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ABSTRACT

Based on the notion that science begins and ends with the natural curiosity that young people have about themselves and the world, this book provides teachers and parents with many options for science exploration. Concepts are developed through science activities, creative arts activities, puzzles and games, and short biographies of individuals who have had an impact on science. This information is organized into four major sections. Part I, The Life Sciences, provides ideas and activities ranging from the microscopic world to human anatomy and ecological factors. Part II, The Earth Sciences, includes lessons on rocks and minerals, aquatic ecosystems, hydrology, and the weather. Part III, The Physical Sciences, consists of experiments and information about molecules, energy, magnetism, electricity, and gravity. Part IV, The Aerospace Sciences, presents activities dealing with flight and astronomy. A final section of the book explores science fiction, ESP, and provides gamebords and reproducible illustrations to be used in some of the games and activities. (TW)

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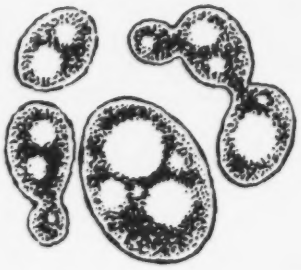
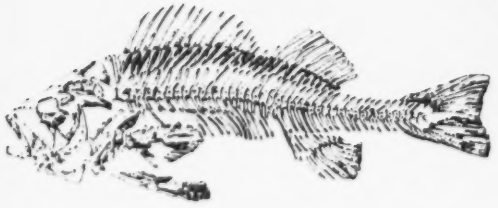
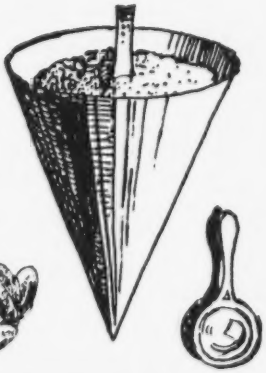
FOR KIDS OF ALL AGES

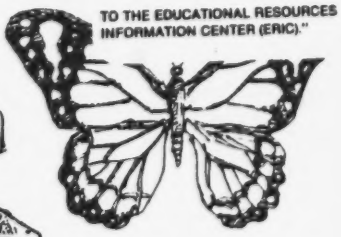
THE WHOLE COSMOS

CATALOG OF SCIENCE ACTIVITIES









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FOREWORD BY BOB SAMPLES

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THE WHOLE EARTH CATALOG OF SCIENCE ACTIVITIES

JOE ABRUSCATO
UNIVERSITY OF VERMONT

JACK HASSARD
GEORGIA STATE UNIVERSITY

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The Whole Cosmos Catalog of Science Activities came into being because so many people were willing to share their talents and energies with us. We would like to mention a few of them.

Our editor David Grady's insights, creativity, and positive attitude provided us with continued encouragement. Janice Gallagher, our production manager for this volume, helped us through all stages of its development. She helped make the "nitty gritty" a lot less gritty. Through the creative abilities of designers John Isely and Tom Lewis, our words have taken on a visual dimension. Jackie Estrada, our copy editor, is to be complimented on catching our slips of the pen. Ted Hipple's continuing faith in this and our other projects is also greatly appreciated.

We also had our own "production" staff: Sandy Booth, Birute Conley, Virginia Wolfe, and Kay Wyatt in Atlanta; and Mary Lou Wasko and Robin Benoit in Burlington. These fine people were somehow able to transform our scratchings into a typed manuscript.

There are several persons whose very special, creative talents have helped shape specific parts of the book. Julia Griffin of Atlanta wrote several original poems. Patty Zeitlin and Ruth Buell of Los Angeles shared some of their beautiful music. Pat Sommerkamp from Erlanger, Kentucky, provided us with a play. Pete Shepherd, a student from the Atlanta area, shared one of his original science fiction stories. We thank each of you.

There are so many other people who mean a lot to each of us — preservice and inservice teachers, curriculum coordinators, college and university colleagues from across the country — who join with us in the belief that the act of learning can and should be a marvelous experience. They continually share their spirit, love, insights, and experiences with us. Each day they help us keep fresh the dream.

DEDICATION

This book is dedicated to

Charlotte Bates Abruscato
Beth Abruscato
Anne Marie Abruscato

John Hassard
Jennifer Hassard
Jake Hassard

People who bring joy, life, and love to us.

FOREWORD

This book is fun. It is fun to read and fun to use and it is fun to write an introduction to. I have no doubts that it was also fun for Jack and Joe to write. With all this fun, does that mean it does not contain any serious science?

Of course it contains serious science, but this book also contains the courage to be honest. Science *is* fun. It always has been. In the presence of the joy of creating and discovering, there is always the sense of the antic. Jerome Bruner said it best when he described the act of creativity. He said, "There is something antic about creating, although the enterprise be serious."

Learning is creating. Learners take their old, unstructured, informal experiences and wed them to new, immediate experiences. Out of this wedding they create a bit of transformed knowing. As they acquire that "new knowing" they are said to have "learned" something. Unfortunately, educators and psychologists have spent too much time looking at the knowledge that is acquired to be concerned with what the learner does in that antic interlude just before the so-called learning takes place. There is magic in those moments.

It is in those moments that the fun of learning is most apparent. Later, the new knowledge slips into schemes of logic. A new box is created in the mind. As one looks upon what is learned it is hard to tell the new knowing from the old — except that the new is more organized, easier to get to, and more logical.

To the learner, there is seduction in the knowledge boxes. These boxes can, as useful as they are, force one into believing that learning is over. They can become an end in themselves. They can become coffins in the mind.

On this macabre note, let us switch metaphors. Let's move to a beehive. Hives are filled with boxes and the boxes are filled with honey. Each season the bees gather nectar and convert it to honey and house it in a box within the hive. The honey, like knowledge, is there to be consumed. However, it is never *all* consumed before a new generation of honey is created.

So the hive cores, like the logical boxes in our minds, only provide a framework for knowing. A framework that is forever modified and renewed. In this book, there is as much emphasis on renewal as there is on formal, structured knowledge. Jack and Joe provide a wide array of experiences for the student and teacher. Box makers and honey makers alike will have a rich variety of experiences. Bees specialized in either function are invited to experience both tasks.

There are specifics in this book for those who seek tidiness and systems in thinking. There is ambiguity for those who would choose decision making and discovery. In a word, there is *science* in this book.

But science is not all that is here. There is also *humanness*. So often left out of educational materials, humanness is a central issue to the lives of the authors. Their own warmth, compassion, and good humor come charmingly through these pages. They have the grace *and* wisdom not to confuse the contents and the container. They cherish both the hive and honey, but even more important, they cherish the bees . . . the students and the teachers. And after all, the *whole* picture is what education is all about.

Bob Samples
Tiburon, California

TO OUR READERS

NOTE TO TEACHERS

Science teaching begins with wonder and ends with wonder. Science appeals directly to the natural curiosity that young people have about themselves, their world, and the cosmos. When you teach science, you get a chance to become involved and do things with your students. For your students, science class is a concrete, real, touchable, smellable happening in the course of the school day. Science is for the here and the now and this book has been designed to help you put more wonder, awe, mystery, and excitement into your science teaching.

The Whole Cosmos Catalog of Science Activities *is more than an experiment book — it is a source of ideas and activities that can provide you with many options for science exploration. We have taken several major topics considered in the science curriculum and have included activities of four major types: science activities, creative arts activities, puzzlers and games, and science biographies. In addition to these, the last section of the book contains full-sized board games and other nifties.*

In the event that you are using a specific textbook series or curriculum in your teaching of science, you may be interested in incorporating the ideas and activities in **The Whole Cosmos Catalog of Science Activities** *in your planning. This can be accomplished quite easily either by using the table of contents or by consulting the index.*

You may find that some of your students need to be involved in a more independent and individualized study of science than is provided by conventional classroom texts. These students may benefit by having their own copies of **The Whole Cosmos Catalog of Science Activities** *to use as a sourcebook for independent work.*

If you have an interest in securing additional ideas and activities for teaching science in a more humanistic way, you may wish to refer to the authors' science methods and activities book, **Loving and Beyond: Science Teaching for the Humanistic Classroom.** *It is also available from Goodyear.*

We wish you the very best as you strive to put more zing into your science teaching. Enjoy!

NOTE TO YOUNG PEOPLE

You are probably a person who is curious about the world around you. Have you wondered about the weather, or magnets, or the stars and planets? Are you a collector? Do you like to collect rocks, or leaves, or seashells? Do you like to ask questions and try to experiment with different things? If you are interested and curious about such things as how your body works, the world around you, or the stars above, this book will give you many hours of good fun and good learning.

Look at the table of contents. You may notice that we have included many kinds of activities so you can select the kinds of things you are interested in doing. The main kinds of activities are:

1. **SCIENCE ACTIVITIES**
   Most of the things you need in order to do them can be found in your home or at school.
2. **CREATIVE ARTS ACTIVITIES**
   Arts and crafts, poetry writing, and other things you can do to express yourself about science experiences.
3. **PUZZLES AND GAMES**
   Puzzles, word games, and other things you can do by yourself or with friends. Plus, the last section of the book contains a collection of full-sized board games and other nifties to give you hours of science enjoyment.
4. **SCIENCE BIOGRAPHIES**
   You can read about some very interesting people who have done important things in science and use them as examples for your own life.

We hope you enjoy exploring your world and we hope you stay curious throughout your life. Good luck!

NOTE TO PARENTS, RELATIVES & OTHERS

This book could be the source of many hours of enjoyment and learning for any boy or girl who is curious about the way things are. It is a book that encourages youngsters to become involved, to explore, to find out, and to become even more curious about their world and the cosmos.

The Whole Cosmos Catalog of Science Activities *begins with a table of contents that the young person can use as a guide to select activities and experiences that suit his or her interests. In each chapter of the* **Catalog,** *there are four main types of experiences or activities:*

1. **SCIENCE ACTIVITIES**
   This consists of a number of experiments that the child can try at home or at school. All the materials are safe and readily available.
2. **CREATIVE ARTS**
   The process of discovery and the sharing of discoveries can be experiences that have an aesthetic or arts-and-crafts dimension. Activities that can assist in self-expression through the creative arts are included in each chapter.
3. **PUZZLES AND GAMES**
   There are learning games and puzzles throughout the book. Some can be done by one person and some require a group.
4. **SCIENCE BIOGRAPHIES**
   The authors believe that youngsters can form an incorrect opinion of the nature and role of scientists from the mass media. The image of the elderly, white, male, gray-haired wizard fumbling with test tubes does not provide a helpful role model. We have included a brief biography of a scientist for each section, emphasizing scientists' human side. Some are female, some are black, and none seem to be wizards.

We hope you enjoy giving this book and sharing in the joy of learning.

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CHAPTER 1

MINI-BEASTS AND THE INVISIBLE WORLD

There are many living things that are so small that we can't see them using our ordinary vision. Some are plants and some are animals. There are even some tiny living things that seem to act like a combination of a plant and an animal (a plantimal?).

In this section we show many ways to find out about the millions and billions of living things that are so tiny they seem to be invisible. We also describe a way to raise and study mini-beasts. And in a "food for thought" activity involving the study of the mini-plant called yeast, we show how to make a delicious loaf of bread.

Catching & Growing Small Living Things

AMOEBAE

Amoebae are tiny one-celled animals that are found in ponds, streams, and lakes. They are interesting to study under a microscope and are fairly easy to find in nature. Here are two methods you can use to try to find some amoebae to study.

METHOD 1

1. Find a nearby pond, lake, or stream that contains fairly clear water. (This may be pretty hard to do if water pollution is a problem where you live.)

2. Take a quart or liter of water from the pond. Also collect a handful of dry hay or dry grass and add it to the water. Put the water and hay (grass) in a small aquarium or plastic bucket. Cover the container and leave it at room temperature for about a week.

3. To try to find the amoebae in the jar of pond water, use a medicine dropper and take samples of clear water from the sides and bottom of the container. Try not to get the green material growing on the top of the water in your sample. Place each drop on a microscope slide and cover it with a cover slip. Look carefully at all parts of the droplet, and you may find a one-celled amoeba moving through the water. There may be other one-celled plants or animals in the water also.

METHOD 2

1. Find a pond or stream that has water lilies or cattails growing near its edge.

2. Take a pint or half liter of water from the pond. Pick a water lily pad and scrape a little of the underside of the leaf into the jar. If cattails are growing, pull one out and scrape some parts of the base of the stalk into the jar.

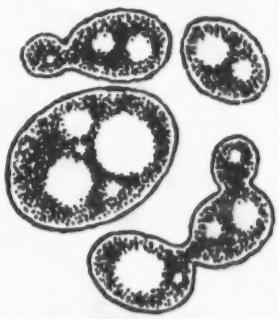
3. Take the jar of water indoors and add three or four grains of uncooked rice to the water. Cover the jar and let it sit for a week.

4. Use a medicine dropper to take samples of water from the sides and bottom of the jar. Place a drop on your microscope slide and enjoy your hunt for the tiny animals.

YEAST

A Tiny Plant

The dry yeast that is used for baking is really a group of tiny plants. Yeasts are one-celled nongreen plants that cannot make their own food. In this activity you will have a chance to get these tiny plants to grow and then look at them under a microscope.



YOU PROBABLY WILL NOT SEE THE YEAST CELLS THIS CLEARLY, BUT THIS WILL GIVE YOU A GOOD IDEA OF WHAT TO LOOK FOR. NOTICE THE PLANTS "BUDDING."

1. Get a fresh package of yeast. Check the side of the package for the freshness date. Be sure to keep the yeast in the refrigerator until you are ready to start your experiment.

2. In order for the yeast plants to grow properly, they need sugar, water, and a temperature that is warm but not hot. You will be growing your yeast plants in a warm sugar solution. To make the solution, dissolve 1½ tablespoons of sugar in a cup of warm water.

3. Open the package of yeast and dissolve one teaspoonful of yeast in the warm sugar solution.

4. Put a drop of the solution containing the yeast on a microscope slide. Look at it under a microscope. Don't expect these plants to have roots and leaves. The large oval-shaped things you see are complete yeast plants.

5. Store half of your yeast solution in a refrigerator. Put the other half in a warm place.

6. After a day look at a drop of yeast solution from the warm place and one from the refrigerator with your microscope. Draw what you see. The small oval-shaped things that seem to be growing out of the sides of some of the big oval cells are new yeast plants, or "buds."

7. Which yeast solution (the warm one or the cold one) has the most new yeast plants?

8. Can you think of other experiments you can try with your yeast plants?

BREAD BAKE

Get yourself set up in a kitchen with an oven and a big work surface. You will need the following tools:

Materials

large mixing bowl
wooden spoon
two bread (baking) pans
small pot

You will need the following food supplies:

package (or cake) of yeast
2 cups of lukewarm milk
2 tablespoons of sugar
1 tablespoon of salt
6 cups of white flour
5 tablespoons of butter

Directions

1. *Pour the 2 cups of lukewarm milk into the mixing bowl.*

2. *Put the yeast into the lukewarm milk.*

3. *Add the sugar and salt to the mixture. Stir with the wooden spoon until the yeast dissolves.*

4. *Add a little of the white flour. As you add the flour, mix up the mixture with the wooden spoon.*

5. *Add a little more flour and mix with the spoon. The mixture will get thicker. Do not add all the flour yet!*

6. *When the mixture becomes hard to mix, start melting the butter.*

7. *Slowly pour the melted butter into the mixture. Mix it in with the spoon.*

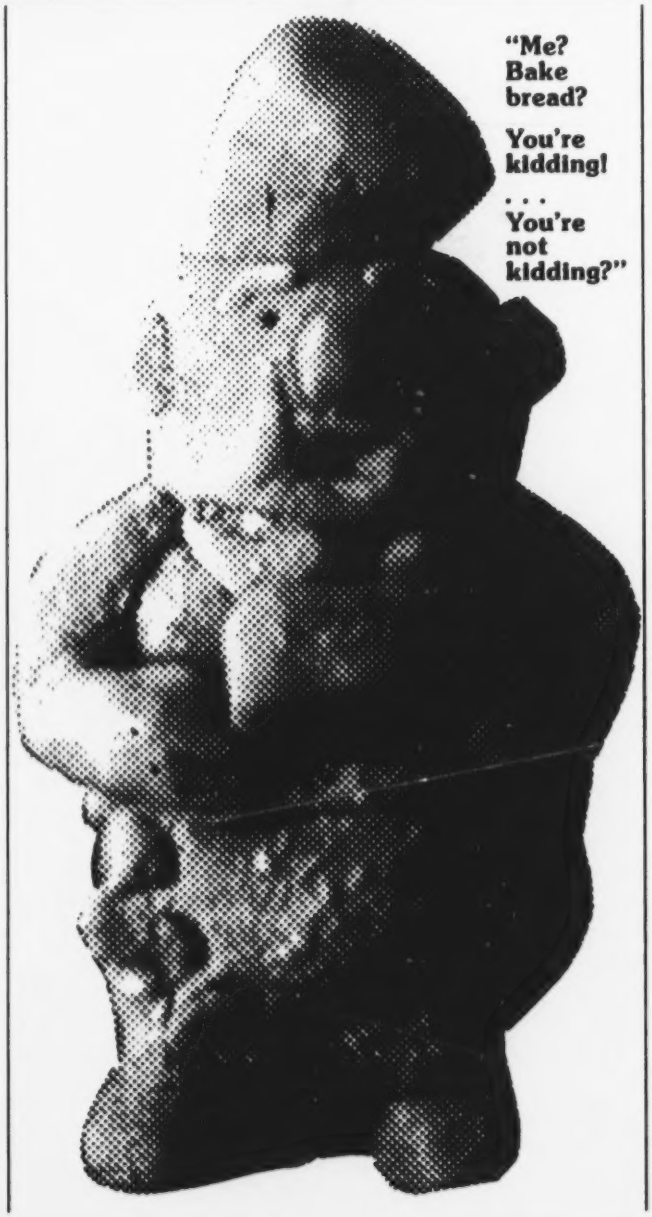
8. *Now add a little more flour. Mix it in with the spoon or your hands. Keep adding the flour until it is all used up.*

9. *Mix up the mixture with the spoon. Use your hands if you wish! When the mixture is smooth and stretchy, step back and take a look at it.*

10. *This is how you knead dough: Fold the dough back on itself and then beat it down. Do this for 5 to 10 minutes.*

11. *Put the dough in the mixing bowl. Cover it with a cloth and keep it warm.*

12. *Leave the dough alone for about 1½ to 2 hours. As you wait, the dough will grow bigger and bigger. Let it grow until it doubles in size. Can you think of a reason that would explain why the dough grows in size? (Answer below)*



"Me? Bake bread?

You're kidding!

. . .

You're not kidding?"

13. *Punch the dough two or three times. What happens to it?*

14. *Sprinkle some flour on a work surface. Knead the dough on this surface for about 3 minutes.*

15. *Break the dough into halves. Shape the halves like small loaves of bread.*

16. *Melt about 1 teaspoon of butter in each of your bread pans. Be sure the inside of each bread pan is coated with butter.*

17. *Put the dough halves into the bread pans. Cover the pans and let the dough rise again until it doubles in size. You are now ready to bake your bread!*

18. *Set your oven at 375°. Put the bread in the oven. Bake for about 45 minutes or until the top of the bread is nice and brown.*

19. *Eat the bread. Isn't it delicious?*

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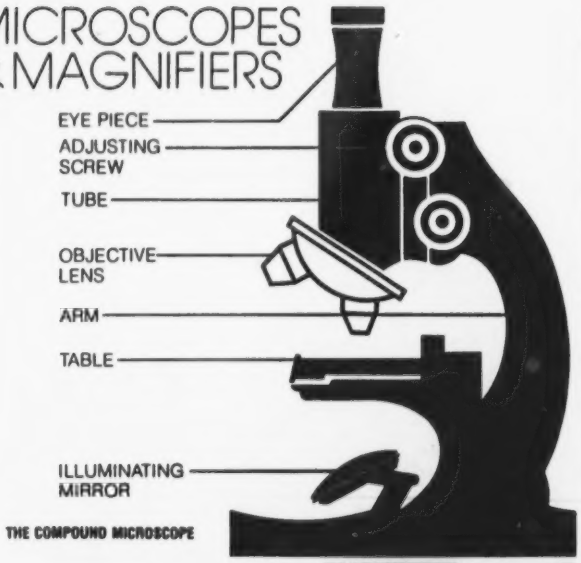
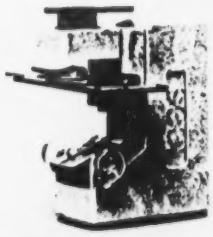
ANSWER

The yeast plants act on the sugar and produce alcohol and carbon dioxide (a gas). When heated, the tiny bubbles of carbon dioxide grow larger and cause the dough to rise. During baking, the bubbles continue to grow and create spaces in the bread. The alcohol goes into the air.

MICROSCOPES & MAGNIFIERS



THE COMPOUND MICROSCOPE



NSCOPE
This is a very inexpensive microscope that is small and easy to use. It sells for $4.00.

30X Field Microscope
This little microscope can be used out-of-doors to make observations during nature walks or field trips. It costs $10.00. For an additional $3.00 you can buy an attachment (called a reticle) that will let you actually measure objects less than 3 millimeters in size.

Both microscopes are available from SEE, Newton, Massachusetts.

HOW TO PREPARE A SLIDE

Use your microscope to look at dust, pepper, thread, or some other small object. Whatever you put on your slide is called a *specimen*. To prepare a slide you'll need:

slide

cover slip

water dropper

specimen

1. What specimen did you choose? Look first at your specimen with your eyes alone and then look at it through the microscope.
2. Do you see bubbles? If you do see bubbles, you may not have lowered the cover slip carefully. Try again until you get all (or most) of the air bubbles out. Look at your specimen again.
3. What does the microscope seem to do to your specimen?
4. Try making a slide without using a drop of water. **Can you see the specimen more clearly with or without water?**

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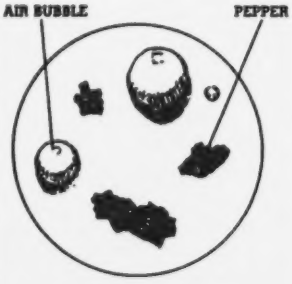
FIRST, PUT YOUR SPECIMEN ON THE SLIDE.

VERY CAREFULLY ADD A SINGLE DROP OF WATER. TO COVER THE SPECIMEN WITH A COVER SLIP . . .

TOUCH ONE EDGE OF THE COVER SLIP TO THE DROP OF WATER. THEN GENTLY LOWER THE COVER ONTO THE SPECIMEN. KEEP THE BOTTOM OF YOUR SLIDE DRY.



GROWING YOUR OWN MINI-BEASTS IN A MICROAQUARIUM

You can easily build a microaquarium. A *microaquarium* is a large culture of microorganisms. You will need sand, stones, raw meat, wire, wood scrapings, pond water, water plants, a small fish bowl, and a glass cover for the fish bowl. You can get your bowl from a variety store.

Put clean sand on the bottom of the fish bowl. Build up the sand to a level of 4 cm. Stuff some water plants from a pond into the bowl. Crowd the bowl with plants, but do not fill it. Add a handful of dried hay. Add some scrapings from an old log that has been lying in the pond water. Also put some slime-coated stones into the bowl. You can find some stones near the edge of a pond.

Fill the bowl with pond water. Hang small pieces of raw meat from the edge of the bowl into the water. Leave the meat in the water for 24 hours and then remove it. Place a glass cover over the microaquarium, but first bend a piece of wire over the edge of the bowl. The wire will allow air to enter the bowl through the space under the cover.

Single-celled microorganisms soon will be living in your microaquarium. Take samples from the water from time to time. Observe the specimens through a microscope. Add pond water now and then to replace the water that evaporates. You can keep your microaquarium active for an entire school year.

From *The Young Scientist: His Predictions and Tests* by John Gabriel Navarra and Joseph Zaffroni, copyright 1970 by Harper & Row Publishers, Inc., New York. Reprinted with permission.

ANTON VAN LEEUWENHOEK— THEY THOUGHT HE FLIPPED HIS WIG AND THEY LAUGHED AND LAUGHED AN[illegible]HED.

Anton van Leeuwenhoek (1632–1723), surprisingly, was not a scientist, but a curious and hard-working businessman who enjoyed grinding lenses and finally invented the tool he called his Microscopia. Little was heard of this industrious man until the year 1673, when he astonished the world by the skill with which he built microscopes and accurately described and measured the many objects he viewed. He described the sting of a bee and the structure of mold. He not only observed corpuscles in blood but measured their approximate size and made accurate drawings of their shape — just as you may do in the weeks to come.

Anton van Leeuwenhoek was a very special kind of man. He hated to stop looking at these fascinating specimens on his microscope. He looked at the same specimen again and again. He looked at it very carefully when he first placed it on his microscope. He looked at it from all angles, but he would not take it off. He looked again an hour later, maybe four hours later, perhaps before going to bed, and again in the morning and a week later and again and again. Some of the specimens changed. For instance, maybe the bee's wing had dried out somewhat. He had to see these changes happening, and he wrote down all of these carefully observed facts.

Now you and I might simply take another slide and put a favorite one aside for viewing later, but not Anton van Leeuwenhoek! He wanted to keep the specimens right on his microscope. There would be only one way for him to do this, and so he did it. He built himself another microscope. When he placed a new specimen on this one and viewed it with the same careful scrutiny he always used, he did not want to remove it; so he built *another* microscope — ten more, a hundred more. He made them all by hand, from the simplest to the most complex part. Because of the many lenses needed for his many microscopes, he became a great lens maker, for he had a great deal of patience and practice.

Unfortunately, because the people in the town of Delft, Holland, laughed at him, he kept the secrets "for himself alone" of how he built his best microscopes and the special methods he used for observing his specimens. It took mankind at least a hundred years to build a microscope as good as those of Anton van Leeuwenhoek because he never wrote down any of his secrets, and they were lost when he died in 1723.

1. Do you ever get interested in something that nobody around you cares about?

2. Do you think you are as patient as Anton was?

3. If you were Anton, what would you do about the people who laughed? Would you ignore them? Argue with them? Laugh at them?

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PUZZLER

HOW MANY TIMES CAN YOU FIND THE FOLLOWING WORDS IN THE PUZZLE?
SUGAR, WATER, YEAST, AMOEBA, MOLD, CULTURE, PLANT, SLIDE, ANIMAL.
CIRCLE THE WORDS AS YOU FIND THEM.

```
O Q X A M O E B A P T A W V
R B C N O M O L D Y L M H Y
T U U I L C W A T E R O G W
P C L M D D E M Y A S E I A
L S T A Z I N O E S P B S T
A C U L T U R E A T L A U E
N A R D O V L B S N A X G R
T Y E A S T V A T K N R A B
W A T E R X A C U L T U R E
K D V T M U S L I D E J M C
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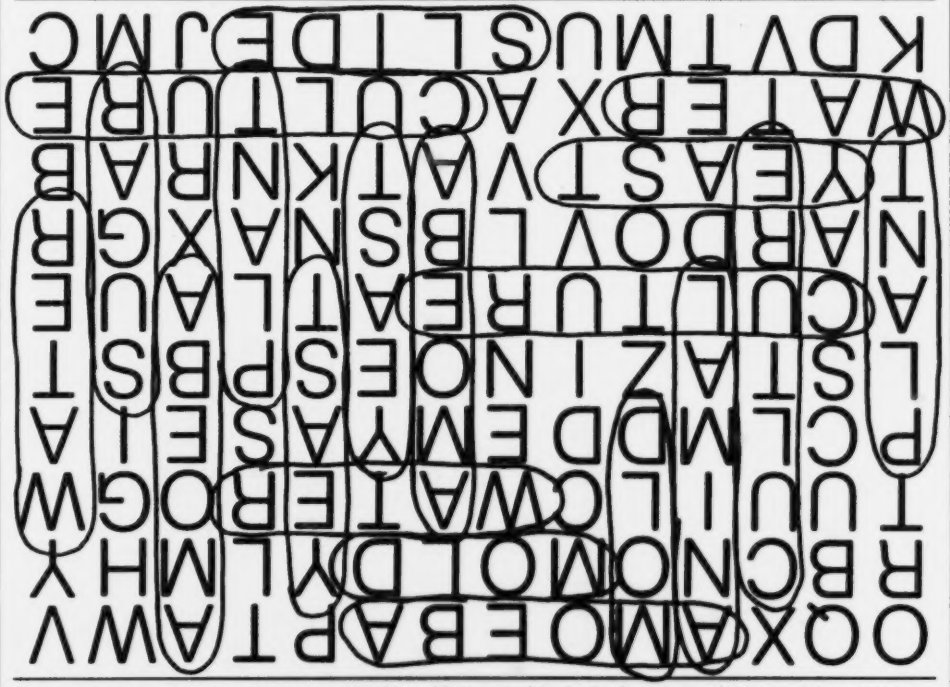
ANSWER TO PUZZLER



CULTURE 3, WATER 3, SUGAR 1, YEAST 3, PLANT 2, AMOEBA 3, MOLD 2, SLIDE 1, ANIMAL 1

ERNEST JUST,
Cell Biologist

Born and raised in Charleston, South Carolina, Ernest Just (1883–1941) started working at the age of four to help support his family after the death of his father. He was an enthusiastic scholar, though, and at age seventeen his mother sent him north for further schooling. He arrived in New York with five dollars in his pocket. Upon learning that his high school education was not adequate to qualify him for college admission, Just enrolled in a prep school in New Hampshire, completing the four-year program in only three years. He then entered Dartmouth College. It was there that he became fascinated with cell biology. After graduating magna cum laude in 1907, he accepted a job at Howard University and in 1912 became the head of the Biology Department. From 1909 until 1930 he spent time each summer at Woods Hole, Massachusetts, a gathering place for marine scientists of all kinds. He used marine life in his study of the cell. Just took a number of controversial stands on the nature of the cell and, as is the case with many controversies, he and his opponents were both partly right and partly wrong. Through his carefully prepared and documented experiments, however, Ernest Just gained the complete respect of the entire scientific community. Ernest Just died of cancer at age fifty-eight.

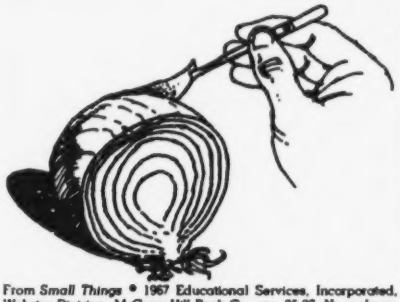
1. Ernest Just was a person who stood up for what he believed in. Make a list of some of the things you strongly believe in. Which of these would you publicly stand up for?

2. Are any of the things you listed controversial? Have you ever discussed these controversial things with others? How did you feel?

THE INVISIBLE WORLD OF THE ONION . . . THE ONION ?

Perhaps you think you have really seen an onion. Have you? You can help your eye by looking at an onion with a hand lens.

1. How does the lens help you to see the onion?
2. Layer by layer, gently separate the onion. Look at one of the layers through the hand lens. Look at its inner edge. What do you see that you had not seen before?
3. Break a layer and use your tweezers to pull it apart. Try to find what separates the parts of the layers. What did you find?
4. Now carefully peel off a piece of the thin skin found on the inside of each layer. Try to lay it on a slide without folding it. Hold it up to the light and look at it through your hand lens. What can you see?



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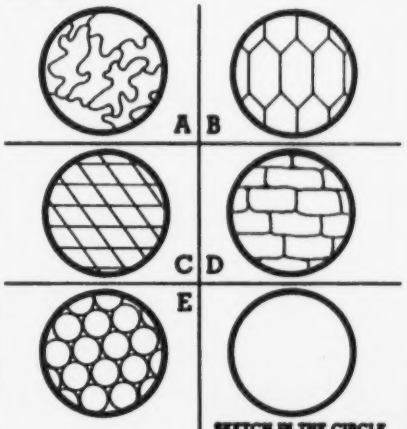
HELPING YOUR EYE TO SEE STILL MORE

You can use the microscope to see still more of an onion. Take a piece of the thin onion skin smaller than your fingernail. Place it on a microscope slide and put a drop of water on it. Put the cover slip over the onion skin — carefully!

Look at your slide through the microscope and tilt your mirror back and forth. Does adjusting the light help you to see the onion skin better? Try to get a bright field in your microscope. Now get a dark field in your microscope.

1. Do some parts of the specimen stay light and shiny more than do others?
2. Which of the drawings below looks most like what you see of the onion with your microscope?
3. How would you describe the shape of the things you see?
4. Do they seem to have anything in them?
5. Are the blocks all exactly the same size, or are they slightly different?
6. Are they all exactly the same shape, or are they slightly different?

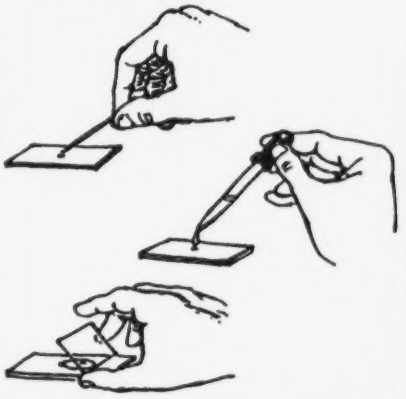


SKETCH IN THE CIRCLE WHAT YOUR SPECIMEN LOOKS LIKE.

USING INK TO MAKE MORE OF THE INVISIBLE WORLD VISIBLE

Scientists have found that they can study microscopic things better if they add a little dye to the materials they are looking at. You can do the same thing using two kinds of dye that you can get in any stationery store: permanent red fountain pen ink and permanent blue fountain pen ink.

When you looked at onion cells



with a microscope you probably noticed that the cells you saw were very white. By staining an onion slide you'll be able to see some things very clearly that you missed seeing the first time.

Using a toothpick, pick up a little of the red ink. Touch the toothpick to the onion skin and then add a drop of water to the slide. Put the cover slip on the onion skin. Make a drawing of what you see.

Try this with the blue ink on a different slide. What things did you get to see better by staining the slide?

OTHER INVISIBLE WORLDS TO EXPLORE

The microscope can be a great tool to use to explore the invisible worlds that are right around you. Here is a list of some things you may wish to investigate using the microscope:

MEAT INK
CELERY
FIBERS
DUST
SUGAR
SALT
AND
SOIL
PEPPER
APPLE
FEATHERS
HAMBURGER

When you are preparing slides, be sure to use very small quantities of the things you want to look at. When using plant material, always add a drop of water to keep the cells fresh.

SOME INTERESTING BOOKS

Algae by Harold E. Schlichting Jr. and Mary Southworth Schlichting. Austin: Steck-Vaughn, 1971, $2.95.
The Amoeba by Sean Morrison. New York: Coward, McCann and Geoghegan, 1971, $4.39.
Exploring with a Microscope by Seymour Simon. New York: Random House, 1969.
Life in a Drop of Water by George Schwartz. Garden City, N.Y.: Doubleday, 1970.
Magnify and Find Out Why by Julius Schwartz. New York: McGraw-Hill, 1972, $4.95.
Microbes Are Something Else by A. Harris Stone and Irving Leskowitz. Englewood Cliffs, N.J.: Prentice-Hall, 1969.
The Microscope and How To Use It by George Stehli. New York: Dover, 1970.
The Scanning Electron Microscope by C. P. Gilmore. Greenwich, Ct.: New York Graphic Society, 1972, $15.95.

MAKING A SPORE PRINT

Mushrooms are plants that reproduce through production of spores. New mushrooms grow from the millions of tiny spores that leave the mushroom when it's ripe.

In this art activity you will be catching these tiny spores and preserving the beautiful pattern they form as they leave the underside of the mushroom cap.

In order to make a spore print, you will first need to find some mushrooms. The best places to look are shady moist areas. If you live near a park, a wooded area, or a meadow with some shade, you'll probably be able to find some a few days after a good rainstorm.

Look for mushrooms that have recently opened. These mushrooms are ready to spread their spores. Mushrooms that are still closed will not work for this activity.

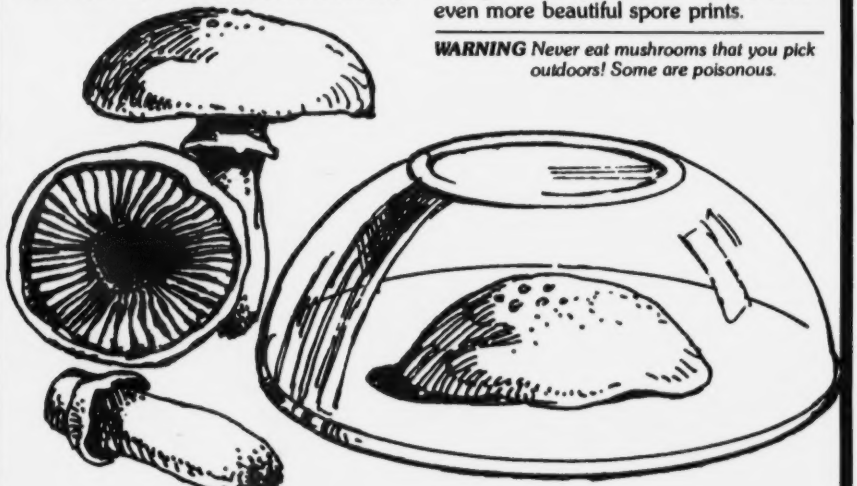
Take the mushrooms indoors and carefully break off the stalks beneath the caps. Throw the stalks away. Lay the mushroom caps on sheets of construction paper. Since most mushrooms produce spores that are dark in color, construction paper that is light tan or off-white will work best. Cover each mushroom cap with a bowl and leave it overnight. The bowl keeps air currents from blowing the spores away.

The next day carefully remove the bowls. Then lift the mushroom caps up without jiggling the paper. If your mushrooms are ripe, you should have a set of beautiful spore prints.

To preserve the prints you will need to buy a small can of fixative and carefully spray the print. Be sure to aim the nozzle at the print and not at yourself. Also, try to keep the spray can at least one foot from the print. If you hold it too close, the spray will blow the spores off the paper. After the fixative dries you can frame your spore prints.

Something else you can try is arranging the mushroom caps together on one piece of paper. Then you will be able to have even more beautiful spore prints.

WARNING *Never eat mushrooms that you pick outdoors! Some are poisonous.*



We wish to thank Ted Colton of Georgia State University for sharing the ideas upon which this activity was based.

Sunday stroll on the moon in the year 2080.

CHAPTER 2

SAVE THE EARTH

All living things on our beautiful planet depend on the environment to provide the food and water necessary to grow and to live. Plants need animals and animals need plants — and both need an unpolluted environment.

As our earth whirls through the universe, we all need to do our share in keeping the air, water, and land as healthy for life as possible. By doing this, we can preserve the delicate balance among living things.

If we can learn enough about the effects of pollution, saving threatened wildlife, preserving natural environments, and getting good food from the land without destroying it, there may still be time to save the earth. The activities in this section have been developed to help young people and adults learn to give life a chance.

1. How does this cartoon make you feel?
2. Pretend you are a newspaper reporter who covers events on the moon. Write a story that would be printed along with this cartoon about the moon's environment.
3. Create your own posters and cartoons about the earth's environment.

To Seed or not to Seed

You can plant your garden plot with seeds or with seedlings (young plants that you start yourself indoors or plants that you buy from a nursery). If you live in a climate that has a very short summer, you will have the most success by starting with seedlings.

Planting with Seeds

Visit your garden supply store and look over the supply of seeds. Read the backs of the seed envelopes, and select only those kinds of seeds that will do well in your area. The seed packages usually show the climate area (zone) for which the seeds will work best. If you are not sure, ask for help from the salesclerk.

When you are ready to plant the seeds, be sure to follow all the directions on the package.

Planting with Seedlings — Getting a Head Start

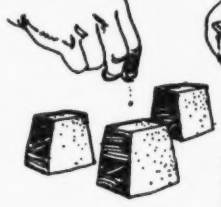
Your garden supply store or local nursery will probably have a supply of little plants for sale. Another way to get the little plants (seedlings) is to grow them yourself. If you are going to grow your own, you will have to plan on growing them at least a month before you take them out-of-doors for planting in the garden plot. You should start the plants in very late winter or early spring, so that you will be transplanting them at a time that will give them a long growing season.

Here are two ways of getting plants started indoors. The pictures show how to do this for tomato plants, but you can use the same idea for any seeds. One-step and two-step methods are shown. If you choose the two-step method, you will need to buy a bag of something called "vermiculite" at the garden supply store. Vermiculite holds moisture very well and is good to start seeds in.

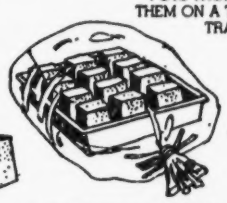
After the seedlings have sprouted and are doing well, you will need to transplant them to small pots containing a good garden soil. You can use the topsoil from a garden plot for this, or you can buy a bag of potting soil at the store.

ONE-STEP METHOD

1. PUT TWO SEEDS INTO EACH GROWING CUBE OR PEAT POT.



2. MOISTEN THE CUBES OR PEAT POTS THOROUGHLY AND PLACE THEM ON A TRAY. PUT THE ENTIRE TRAY IN A PLASTIC BAG.



3. WHEN THE PLANTS ARE ABOUT 13 CM (5 INCHES) HIGH, THEY WILL BE READY TO TRANSPLANT.

TWO-STEP METHOD

1. PLACE THE SEEDS IN A SMALL TRAY OF VERMICULITE.

2. MOISTEN THE VERMICULITE. PUT THE TRAY IN A PLASTIC BAG AND THEN PUT THIS LITTLE GREENHOUSE IN A WARM PLACE.

3. AFTER THE FIRST LEAVES ARE FORMED, GENTLY REMOVE SEEDLINGS FROM THE TRAY.

4. PLANT THE SEEDLINGS IN PEAT POTS THAT ARE FILLED WITH POTTING SOIL. AFTER THE SEEDLINGS ARE ABOUT 13 CM (5 INCHES) HIGH, YOU CAN PLANT THE PEAT POTS IN YOUR GARDEN.

FILTERING OUT SOME WATER POLLUTION

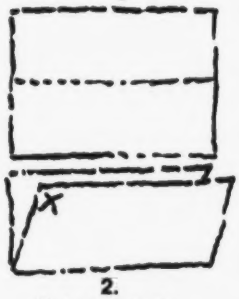
One type of water pollution is caused by solids that are found in water supplies. By filtering water you can remove the solids. Water that has been filtered is not safe to drink because some pollutants, such as bacteria and chemicals, cannot be filtered out.

In this activity you will need some small jars with tops, one large jar, paper towels, and a funnel.

MAKING FILTERS

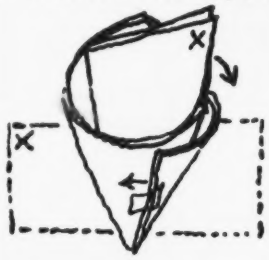
1.

Take a paper towel and fold it in half lengthwise.



2.

Put an X in the upper-left-hand corner. Now roll the folded towel into a cone so that the X is inside the cone. Tape the outside of the cone so it doesn't open.



3.

Look down the cone and notice the hole in the bottom. This hole will let the solids go through, so we need to cover it.

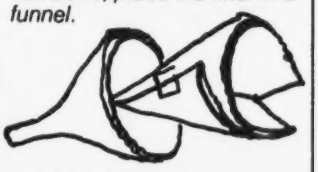
4.

Reach into the top of the cone and put your finger in the fold by the X. Separate the fold and push it to the side. The X should not be visible and the hole should have disappeared.

5.

You now have a filter. Make at least ten of them.

Since the filter is only paper, it will not be strong enough to hold very much water. To solve this, place the filter in a funnel.

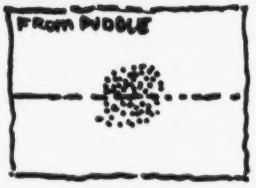


FILTERING WATER

Use your small jars to collect samples of water from streams, ponds, or lakes. Also collect a small jar of tap water. Mark the jars so that you know where the water came from.

1.

Place a funnel containing one of your filters in the neck of the large jar. Pour a jar full of your collected water through the funnel and filter.



2.

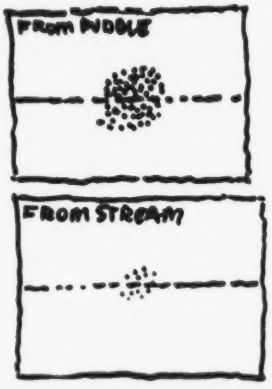
Remove the paper towel filter cone and open it up. On it, write the name of the place where you collected the water sample.

3.

Repeat Step 2, using the same amount of water from each sample with a new filter cone. Be sure to label each used cone.

4.

Compare the amount of material filtered out, the color of the filtered materials, and the kinds of particles that were caught by your filters. Which sample of water had the most solids in it?



Water that has been filtered usually looks cleaner than it did before it was filtered. Filtering is one of the first steps in making water safe to drink, but filtering water is not enough. Even though filtering makes water clearer, harmful bacteria and poisonous chemicals may still be in the water, so **don't** drink it.

BASIC SCIENCE TOOL KIT

The Basic Science Tool Kit developed by Ted Colton of Georgia State University contains a magnifying glass, a metric rule, a metalbacked thermometer, tweezers, two vials with caps, an eye dropper, and a calibrated plastic cup. The kits are sold in quantities of ten for $22.40, so you'll need to get some friends or classmates together to order them.

The Basic Science Tool Kit is available from Science Kit.

BOOKS TO HELP YOU LEARN ABOUT ECOLOGY

ABC's of Ecology by Isaac Asimov. New York: Walker, $4.50.

Animals of the African Year: The Ecology of East Africa by Jane Burton. New York: Holt, Rinehart and Winston, 1972, $10.95.

Animals of Europe — The Ecology of the Wildlife by Maurice Burton. New York: Holt, Rinehart and Winston, 1973, $11.95.

Consider the Process of Living by W. H. Eddy Jr., G. S. Leon, and H. C. Milne. Washington, D.C.: Conservation Foundation, 1972, $5.95.

Ecology: The Circle of Life by Harold R. Hungerford. Chicago: Childrens Press, $3.65.

The Everglades Today: Endangered Wilderness by George X. Sand. New York: Four Winds Press, 1971, $5.61.

Guardians of Tomorrow: Pioneers in Ecology by S. Carl Hirsch. New York: Viking Press, 1971, $4.53.

Magic of the Wilderness by Max Albert Wyss. New York: Viking Press, 1973, $10.95.

Should Trees Have Standing? by Christopher D. Stone. Los Altos, Calif.: William Kaufmann, 1974, $2.95 (paper).

Turtles — Extinction or Survival by Sarah R. Riedman and Ross Witham. New York: Abelard-Schuman, 1974, $6.95.

Vanishing Wildlife of North America by Thomas B. Allen. Washington, D.C.: National Geographic Society, 1974, $4.75.

BECOMING AWARE OF YOUR ENVIRONMENT

Here are some things you can do to become more aware of the outdoor world:

ACTIVITY	THE ACTION	MORE
"So *Be* It"	In one minute you will become some animal or flower or color or something else. Choose what you will be and express how you feel in any way you choose.	• *Ask other people what they think you should become and discuss their reasons.* • *Design an animal, plant, or thing that has all the most important qualities it needs to be perfect. Role-play it.* • *Choose an emotion. Express how it makes you feel in any way you choose.*
"Deadjoke"	Go outside and tell jokes. Find out what's funny and what's not. Try the same thing inside.	• *Look for humor that seems to be characteristic of cultural groups.* • *Illustrate varieties of humor using other than words: music, body movement, sculpture, and so on.* • *Figure out the differences between humor about cultural and ethnic groups and humor within these groups.*
"Love/ Hate"	Go outside and find things you love and things you hate.	• *If you took photographs or made sketches of these things, arrange them in order from most-loved to least-loved to least-hated to most-hated.* • *Add someone else's photos or sketches to your arrangement. Does this person agree with your ordering? Talk about it.* • *Using any medium, abstractly represent love and hate.* • *Did you find things you should love and should hate or things you really do love and hate? Is there a difference?* • *How do you react toward things you hate? Things you love?*
"WEED SEEDS"	Collect as many weed seeds as you can find. Plant them and grow them. (In early fall, the vacant lots and sidewalks are full of plants from which you can get seeds.)	• *What can you do to change how the plants grow?* • *Design and plant a garden of special and beautiful weeds alongside the school. What reactions do people have to the weed garden?* • *What is a weed? How does a plant become a weed?* • *Write an essay in favor of weeds.* • *Make a collage of weed seeds and other weed parts.*
"ENVIRON ART 4"	Go outside and collect materials you find in your environment and create some art from them. Have each piece of art show one of the following: how ugly your environment is. how beautiful your environment is. how your environment makes you feel. the joy of your environment. the sadness of your environment. how time changes your environment.	• *Choose a quality of your environment and portray it. Work in groups and repeat the assignment.* • *What determines the emotional qualities of your environment? Who determines them?*
"COMMERCIALLY YOURS"	Create a commercial for some aspect of your environment. Use any medium you choose. Present the commercial to the class.	• *Test your commercial by seeing what sells.* • *Choose something that you think nobody would want and write a commercial for it.* • *Choose something everyone wants and make it undesirable.* • *What is it about a commercial that makes its message believable? Knowing this, design your commercial to be a winner.* • *How many people do your commercials have to reach to change community attitudes? Whom do they have to convince?*

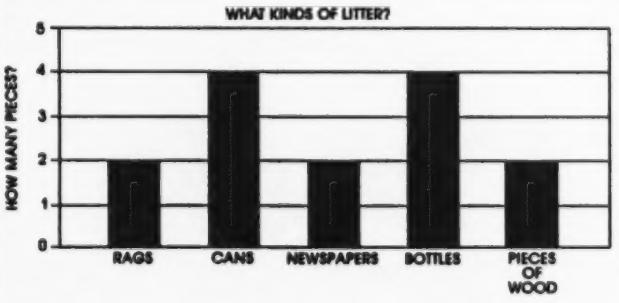
The ten environmental awareness activities are from ESSENCE I, Addison-Wesley Publishing Co., Menlo Park, California, copyright 1971 by the American Geological Institute. Used with permission.

ACTIVITY	THE ACTION	MORE
"JOY"	Go outside and find joy in your environment.	• *Find living and nonliving humorous things.* • *Find sad things. If you can, make them happy things.* • *Using any medium, express the feelings created in you by your environment.* • *Pantomime the things you found.* • *Invent ways to bring more joy into your classroom, your school, your environment.* • *How does your mood affect what's funny and sad? What affects your mood?*
"Feeling Good/Bad"	Map the places in your environment in which you feel the most and least comfortable.	• *Map the places where a cat, a bird, or another person feels most and least comfortable.* • *How does your comfort conflict with the comfort of others?* • *Make the least comfortable places more comfortable.* • *Write something to make someone you like feel good. Write something to make someone you dislike feel good.*
"Simili sound"	Find and bring back sounds that make you feel: angry. sad. beautiful. afraid. happy. tough.	• *Using any medium, represent places and how you feel in them.* • *Instead of emotions, use colors. Try some of your own words.*
"UPS AND DOWNS"	Find something in the environment that is increasing in number and something that is decreasing in number — and prove it!	• *Classify the increases and decreases you found as good, bad, and neutral.* • *Find some things that increase and decrease, but not in numbers.* • *Write a poem in which the number of words per line increases and then write one in which the number of words per line decreases.* • *Make a poster showing things that are increasing and decreasing and indicate your feelings about those things.*

EVERY LITTER BIT HURTS

One way in which people pollute our environment is by littering the ground with papers, cans, and other things that should be placed in trash cans. In this activity you will be discovering the kinds of litter that pollute our environment.

(1.)
Get a basket or a large bag and take a walk in an area where people litter.
(2.)
Collect enough litter to fill your container. If you see rusty cans or broken bottles on your trip, leave them there. These things can easily cut you if you try to pick them up.
(3.)
When you have filled your container, bring it to a place where you can empty it out and look at your collection. What kinds of things did you find?
(4.)
Make a chart showing what you've found. Here is a sample:



(5.)
When you are done, put the litter back in your container and then find a trash can to throw it all into.
(6.)
Where are some other places you could use to study the kinds of littering people do? What kinds of litter do you think you would find in a schoolyard, on a front lawn, in a park, on sidewalks, or in a picnic area?

BOOKS: The Environment, Pollution, and Recycling

About Garbage and Stuff by Ann Zane Shangs. New York: Viking, $5.95.
Easy Experiments with Water Pollution by Harry Sootin. New York: Four Winds Press, 1974, $5.12.
Every Day Is Earth Day by Illa Podendorf. Chicago: Childrens Press, $3.38.
Goodbye, River, Goodbye by George Mendoza. Garden City, N.Y.: Doubleday, $3.95.
Pests and People: The Search for Sensible Pest Control by Laurence Pringle. New York: Macmillan, 1972, $4.95.
Purity or Pollution: The Struggle for Water by Pierre Rondiere. New York: Franklin Watts, 1971, $4.95.
Recycling: Re-using Our World's Solid Wastes by James and Lynn Hahn. New York: Franklin Watts, $3.95.

AIR POLLUTION

MAKING AND USING AIR DIRT COLLECTORS

The following activity will give you a way to find out how clean the air that you breathe is. Air pollution can be of two kinds: solid particles or gases. Studying the amount and kinds of gases that pollute the air is hard to do with simple materials. In this activity you will be studying the solid particles.

The solid particles in the air may come from nature, such as pollen from flowers and dust from the soil. Other solid particles come from the burning of garbage or the burning of coal or oil in furnaces.

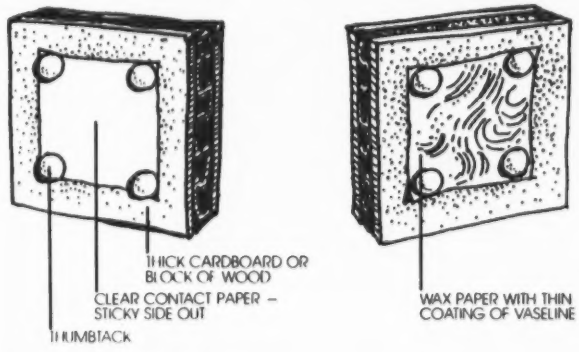
MAKING COLLECTORS

In order to study the particles in the air, you have to catch them on a sticky surface. If you want to study the solids with a microscope, the sticky surface has to be one that will let light shine through. Here are two different ways to make collectors:

CONTACT PAPER COLLECTOR

Get clear contact paper from a stationery or department store (Dennison Clear Seal or any other clear plastic wrap with a sticky side).

Cut the plastic sheet into four to six 10 cm squares. Carefully peel off the backing sheet from each square. Using thumbtacks, attach each square to a small piece of thick cardboard or a small block of wood, keeping the sticky side out.

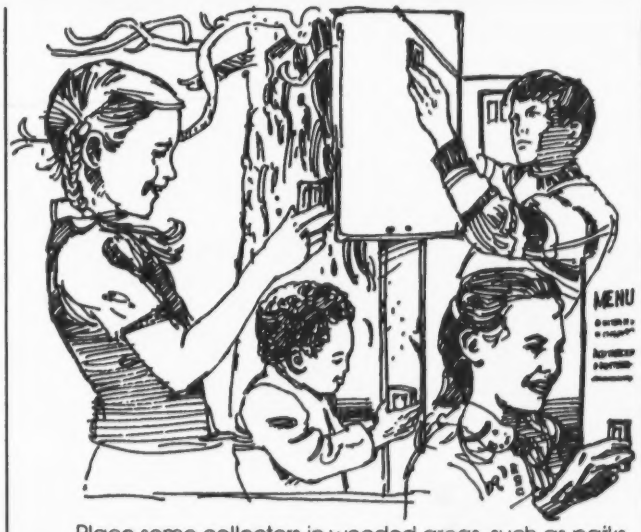


WAX PAPER COLLECTOR

Cut wax paper, clear plastic, or heavy cellophane into four to six 10 cm squares. Thumbtack the material to pieces of heavy cardboard or blocks of wood. Rub a small amount of a petroleum jelly (such as Vaseline) over the surface. Use just enough petroleum jelly to make the surface sticky. The wax paper should still look pretty clear when you are done.

PUTTING THE COLLECTORS OUTSIDE

Find some places in your city or town where you think the air may have a lot of particles in it – perhaps near factories or near streets that have a lot of traffic. Place the collectors where you think no one will disturb them.



Place some collectors in wooded areas, such as parks or picnic spots. Place other collectors indoors at home and at school.

After three days gather your collectors. Mark each with a pen as soon as you pick it up so that you know where it came from. Be careful not to smudge the sticky side of the collectors.

STUDYING THE PARTICLES

Carefully remove the clear sheets from the cardboard or wood blocks.

Using a microscope or a strong hand lens (magnifying glass), carefully observe each collector.

HERE ARE SOME THINGS TO DO:

1. Find out which collectors have the most particles and which have the least particles. (Don't try to count them – just make an estimate.)
2. Make a simple map of the area where you placed the collectors. Mark on the map the places where you studied the pollution. Include information about the amount of particles.
3. Draw the different kinds of particles you've found.

ECOLOGY TAG

As many people as you wish can play this game: Lay out a course about a quarter of a mile long. Designate a place called home base. From there take all the players on a nature hike along the course. During the hike, point out the names of a dozen or so trees, flowers, plants, or rock outcrops.

At the end of the course have players reach into a bag. Those that draw out "It" cards are "It" (one "It" for every five players). The object of the game is to get back to home base without being tagged by an "It" player. Players are safe whenever they are touching one of the identified objects. "It" players may challenge players to name the plant or rock they are touching. If they fail to identify the plant or rock (you might have cards placed on the plants and rocks that can only be read by "It" players to eliminate arguments), they are considered tagged and are out of the game. All players who reach home base are winners.

Variations

(1.)
Only a limited number of players (one or two) may be touching a plant or rock at a given time. Other players must run elsewhere.

(2.)
Players who are tagged or who cannot identify plants or rocks become "It" players.

(3.)
Establish two or more teams, each with its own "It" players. The team with the most players to get back to home base is considered most ecologically knowledgeable.

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MAKING SOME ENVIRONMENTS TO STUDY

You can study the ecology of various environments by making terrariums. Here are the instructions for building three kinds of environments: desert, bog, and woodland.

DESERT TERRARIUM

(1.) Obtain a large, commercial-sized mayonnaise jar.
(2.) Clean the jar with soap and water and rinse it well. Wash and rinse the lid, too.
(3.) Dry off the jar and screw the lid on.
(4.) With the jar on the floor, pound holes into the lid by hitting a nail with a hammer through the lid.
(5.) Place the jar on its side.
(6.) Spread two cups of sand onto the bottom of the jar.
(7.) Place a small bottle cap filled with water, a cactus, and a twig into the jar.
(8.) Place a lizard, skink, chameleon, or horned toad in the jar.
(9.) Cover the jar with the punctured lid.
(10.) Place the jar in a sunny area and water the terrarium once every two weeks.
(11.) Feed the animals live mealworms. These can be obtained from a local pet shop.
(12.) Keep the bottle cap filled with water.

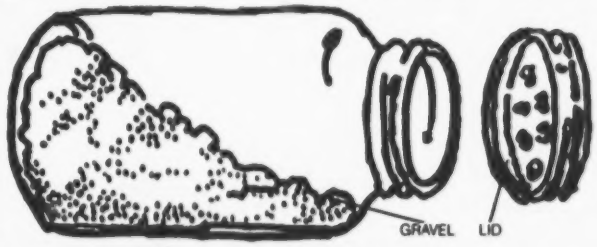
BOG TERRARIUM

(1.) Clean a large, commercial-sized mayonnaise jar with soap and water and rinse it well. Wash and rinse the lid.
(2.) Dry off the jar and screw the lid on.
(3.) With the jar on the floor, pound holes into the lid by driving a nail with a hammer through the lid.
(4.) Place the jar on its side.
(5.) Spread gravel out on the bottom of the jar so it will be concentrated toward the back of the jar, as in the diagram.
(6.) Place ferns, mosses, lichens, and liverworts over the gravel.
(7.) Pour some water in. (Do not put in so much that it covers the back portion of the arrangement.)
(8.) Place a dried twig in the jar.
(9.) Place a small turtle or frog in the jar.
(10.) Cover the jar with the punctured lid.
(11.) Place the terrarium in an area where light is weak.
(12.) Feed the turtle or frog insects or turtle food every other day.

WOODLAND TERRARIUM

(1.) Obtain a large, commercial-sized mayonnaise jar.
(2.) Clean the jar thoroughly with soap and water and rinse it well.
(3.) Find an outdoor area that has plenty of trees.
(4.) In this woodland look on the forest floor for small plants that do not need much light. Try to find such plants as small mosses, baby ferns, or wintergreens.
(5.) Select a few healthy plants of a variety of types. Dig them up with plenty of soil and keep them moist.
(6.) As you are digging, look for small insects and other tiny creatures that live on the woodland floor. Capture these insects carefully and save them for your terrarium.
(7.) Dig up some extra soil to use when you assemble the terrarium. Try to get the dark, moist soil on the surface of the forest floor.
(8.) Collect some small stones and sand to use later as the base for the soil in the terrarium.
(9.) Now you are ready to build the terrarium. Lay the jar on its side and spread the stones on the inside of the jar.
(10.) Moisten the dark soil you have collected and spread it over the sand and gravel.
(11.) Arrange the plants in the terrarium and when you are satisfied with the arrangement, make small holes and bury the "root" systems.
(12.) To make a miniature lake for your terrarium, you can cut a small paper cup in half and use the bottom half as the lake. Bury the bottom half up to its rim somewhere in the terrarium. Fill the cup with water.
(13.) Place the insects in the terrarium.
(14.) Use a piece of plastic wrap and a rubber band to make an airtight cover for the mouth of the jar.

The Desert Terrarium and Bog Terrarium are from Arthur A. Carin and Robert B. Sund, *Teaching Science Through Discovery* © 1970 by Charles E. Merrill Publishing Co., Columbus, Ohio, pp. 570 to 571, third edition copyright 1975, pp. 665 to 666. Used with permission.

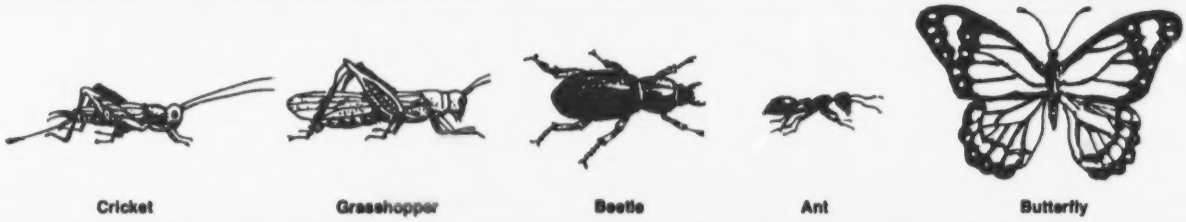


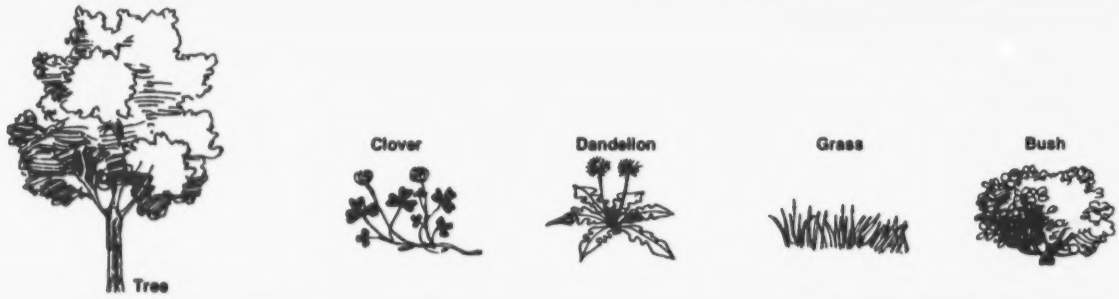
THE CRITTER AND PLANT SEARCH

In this activity, you will become more aware of the kinds of living things that dwell close to your home or school. Find a place nearby that you think might be an interesting area to search.

Take the chart below, a pencil, and a small shovel with you. If you don't have a shovel, find a good digging stick outside. Study your area carefully. If you see something that looks like something on the chart, put a checkmark by its picture. If you see some things that are not on the chart, sketch them where it says "other organisms." The word "organism" means living thing.

An * 1968 Regents of the University of California. No endorsement given.





Other Organisms

Some interesting living things may be under rocks or logs. Use your shovel or digging tool to turn over a little soil to search for living things there. Try not to disturb the living things you observe and be sure to put back any logs, rocks, or soil that you've moved.

Here are some things to think about when you are done with your animal and plant search:

(1.) How many kinds of living things did you find?
(2.) What was the biggest living thing you found? What was the smallest?
(3.) Were you surprised to find some of the things?
(4.) What do you think you would find if you searched the same place next month? Six months from now? Next year?

Ecology Crossword Puzzle

"Crossword" means that the words cross each other. Some words go "across." Some words go "down."

What is the missing word in each sentence below? Find the number of each word in the puzzle. The *first* letter of that word goes in the box with the number.

ACROSS WORDS

"Every litter bit _1_ !"

Trash where it doesn't belong is called _3_ .

The _8_ is what every living thing needs for life. (Already filled in)

_9_ are good to clean with. Save them.

_13_ needs to help the environment.

Each living thing must have _14_ in its environment.

Dirty water from factories kills many _16_ .

People, animals, and _18_ live on the earth.

When you run the shower too long, you _21_ _22_ .

When something is not nice to look at, it is _23_ .

_24_ put much poison into the air.

DOWN WORDS

When you leave a room, _2_ _11_ the lights.

Paper is made from _4_ .

Each living thing must have _5_ in its environment.

The environments of many _6_ have been hurt by man.

_7_ bothers people and hurts ears.

_10_ _12_ good, used items. Don't throw them away.

Too many _12_ have hurt the environment.

Each living thing must have _15_ in its environment.

Most birds eat _17_ .

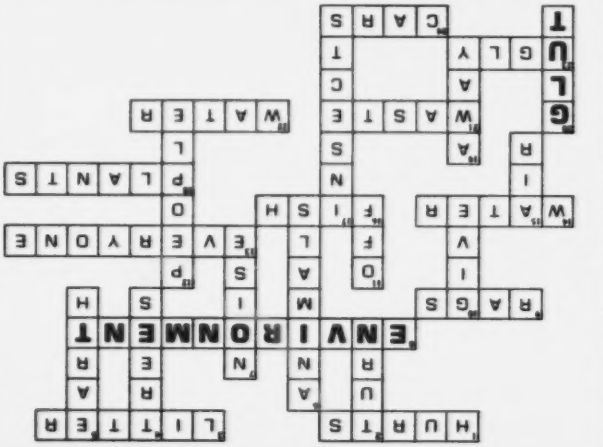
It's easy to be a _20_ . Just "unthink"! (Already filled in)

Litter burg Game

HAVE FUN TRYING TO GET THROUGH THE WORST TOWN IN THE WORLD. TRY GETTING THROUGH LITTER-BURG.

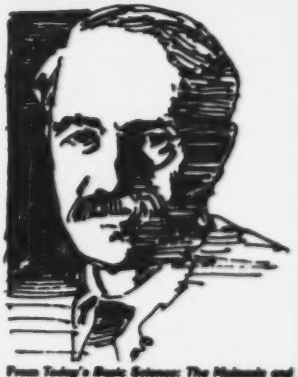
THE DIRECTIONS TO PLAY THIS GAME ARE LOCATED IN THE "GAMES AND OTHER NIFTIES" SECTION.

ANSWER TO PUZZLE



GIFFORD PINCHOT, CONSERVATIONIST

Gifford Pinchot (1865-1946) did much to protect and develop our country's natural resources. He was president of the National Conservation Association from 1910 to 1925 and also served as chief of the U.S. Forest Service from 1898 to 1910. As chief of the Forest Service, he worked closely with Theodore Roosevelt in promoting an interest in conservation. Pinchot was governor of Pennsylvania from 1923 to 1927 and again from 1931 to 1935.



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RACHEL CARSON, CREATOR OF CONTROVERSY

In 1955, one of the most important books of the twentieth century was published. The title of the book was *Silent Spring* and it was written by Rachel Carson. The book caused a storm of controversy. In her book Rachel Carson told a story about the poisoning of our environment by pesticides (chemicals like DDT used to kill insects and other pests). She said that eventually the world would have no spring, that our trees and landscape would be barren, and that fish and other animals would die. When her book first came

out, she was attacked by powerful forces in the United States. But she withstood the storm, and years later environmentalists were able to have antipollution legislation passed. Rachel Carson was a rare scientist. She combined the poetic form of writing, her humanist philosophy, and her knowledge of science to write several important books.

1. Rachel Carson also wrote The Sea Around Us *and* The Edge of the Sea. *Find either of these or* Silent Spring *in the library to find out how and what she wrote.*

2. What is the environment like where you live?

3. Find out if there is a local chapter of the Sierra Club, which is a national association of people concerned about protecting our environment. If there is, find out about some of its activities and publications.

JOHN MUIR, CONSERVATIONIST

John Muir (1838-1914) was among the first observers to recognize the importance of forest conservation in the United States. At Muir's suggestion, President Theodore Roosevelt designated 148 million acres of forests as reserves. As a naturalist, Muir explored plant and animal communities in Europe, Asia, Africa, and the United States. His discoveries support the theory that a glacier carved out Yosemite Valley, a striking feature of Yosemite National Park in California. Muir was born in Dunbar, Scotland. He grew up on a farm in Wisconsin.

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CHAPTER 3

FROM LIFE COMES LIFE

A tiny grass seed falls into a small, thin sidewalk crack
Blowing dust falls into the crack and covers the seed
A few drops of light spring rain wet the dust
around the seed
that is in the concrete
A few days later the seed begins to sprout
A tiny plant begins to grow and
If the rain comes again
If the sunlight is not too strong
If someone's sneaker doesn't crush it, then
This living plant of grass may send out seeds and perhaps...
A tiny seed falls into a small, thin sidewalk crack.

GROWING BRINE SHRIMP FROM FERTILIZED EGGS

Every pet store has a supply of fertilized eggs that you can use to study reproduction. No, not chicken eggs — shrimp eggs. The fertilized eggs of very tiny sea animals called brine shrimp are sold by pet shops as fish food for aquariums.

Brine shrimp eggs are very tiny and you can buy a container that has thousands of eggs in it very cheaply. The eggs in the container are dried and can be kept for a long time. You can save any leftover eggs by keeping the lid on the container and storing the container in a dry place.

In this activity you'll be able to study how the tiny brine shrimp hatch and grow. These animals are so small that you will need a magnifying glass or a simple microscope to study them.

You will need:

container of brine shrimp eggs
small box of noniodized kosher salt
large glass baking dish, small aquarium, or large glass bowl
large cooking pot that can hold two quarts of water
teaspoon
tablespoon or mixing spoon
hand lens or microscope
2 quarts of aged tap water
medicine dropper

Aging Your Tap Water

If you live in a city, water from your faucet has probably had chlorine added to it. The chlorine is added to kill harmful organisms in the water. If you used water straight from your faucet, the chlorine might harm the brine shrimp, so you have to age it. Aging the tap water allows most of the chlorine to escape and makes it safe to use with brine shrimp.

To age the tap water, simply fill a cooking pot with two quarts of water and leave it uncovered for two days, stirring the water from time to time. This will help the chlorine escape.

Making a Salt-Water Solution

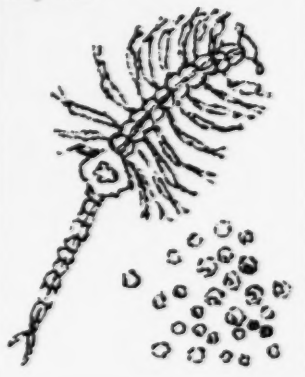
The shrimp eggs will hatch if they are placed in a proper environment. Since brine shrimp are found in nature in salt water, you will need to prepare a salt solution to use for hatching the shrimp.

Place 5 teaspoons of noniodized kosher salt in the 2 quarts of aged tap water. Kosher salt, or any noniodized salt, is needed because the iodine in regular table salt can harm the shrimp eggs. Stir the salt in the water until all 5 teaspoonfuls are dissolved.

Watching the Eggs

Put your salt solution in the glass baking dish, aquarium, or glass bowl. Add ¼ teaspoon of brine shrimp eggs for each quart of water you use. If you can fit all (2 quarts) of your salt solution in the container, use ½ teaspoon of eggs.

Place the container in a warm place. Using a medicine dropper, take a drop of water that contains a few eggs out of the container and view them through your hand lens or microscope. Check a drop of water each day. In about two days you should be able to see some of the eggs hatching. Make drawings of what you see. Here are some things you may find.



PLANT REPRODUCTION SEEDS FROM FLOWERS

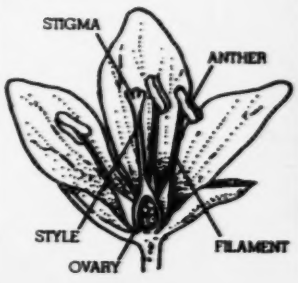
If someone asked you, "Where do plants come from?" you would probably say, "Seeds." What if someone asked, "Where do seeds come from?" Would you say, "Plants"? It sounds as if you might be going around in circles.

In this activity you will learn about the way in which most living things reproduce and how plants make seeds.

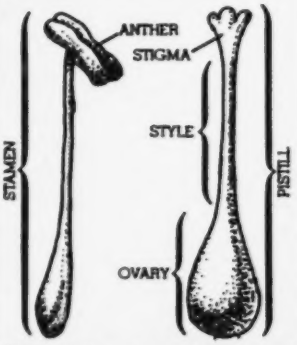
Seeds are formed when pollen from the male part of the flower and an egg from the female part of the flower combine. Reproduction that happens from the combining of special cells from both the male and female parts of a living thing is called *sexual reproduction.*

The flower is the part of the plant that usually contains both male and female parts. Studying the parts of a flower and the way seeds are formed will help you understand sexual reproduction. You will need a tulip or poppy and a hand lens (magnifying glass).

Carefully take a few petals off your flower so you can study the inside. Try to find the parts of your flower that look something like the parts shown in this drawing.



The male part of the flower is called the *stamen.* Find a stamen in your flower. Using the hand lens, compare it to this drawing:



The *anther* is at the top of the stamen and is the place where pollen is made. Pollen is a powdery, grainy substance. Each pollen grain is a sperm cell. Can you find any pollen on the anthers of the stamens of your flower?

The female part of the flower is called the *pistil.* Find the pistil in your flower. Draw the pistil of your flower and compare it with the drawing. You will have to open the base of the flower in order to find the *ovary.* The ovary produces cells (called "ovules" or "eggs") that will become seeds if sperm cells combine with them.

Wind or insects brushing against the anthers may carry pollen grains to the *stigma.* Using your hand lens, check the stigma of your flower to see if any pollen has landed on it.

When a pollen grain lands on the stigma, it begins to form a tube that grows through the *style* toward the ovary. The style is the thin part of the pistil between the ovary and stigma. Parts of the pollen grain move through the tube and combine with the ovules. This is called *fertilization.* These fertilized egg cells (ovules) will eventually form seeds. Open the ovary of the flower you are studying. Try to find the cells that will become seeds.

FROM BIRTH TO LIFE

Birth
Destination

Slow
Slower than a turtle
so you came creeping

pink, pale
virtues contained in a male
fat-rolled body,

the world opened
Wide
its faces to greet you

flowers bloomed trees signed
eternal spring embraced
you running on legs alone

your mind fed madly
too rapidly integrating
world simplicity

Complex
patterns
Addictions

to idols
attic
starship

the Maze
encased you
Can you explicate your
lingering your longings

"Birth Destination" © 1976 by Julia Gallin. Used with permission.

Birth brings us into a very complicated world. The poem "Birth Destination," tells a story of how birth opens the door to life, which can be overwhelming. The poem talks about a choice we have: We can choose a life that is simple and that may lead to inner peace, or we can lead a life that is very complex.

To become aware of the feelings involved in this poem, you'll need a bed sheet and someone to read you the poem. Get under the sheet and get into a fetal position. While under the sheet, have the first three stanzas of the poem read to you. When the flowers have bloomed at the beginning of the fourth stanza, begin to move slowly out from under the sheet. When the poem ends, you should be completely out of the sheet.

When you have completed the poem, discuss the following points with others who also underwent the same experience.

1. How did it feel being under the sheet? Did you feel secure? Did you want to leave?

2. How does this poem relate to your life? Are you moving toward simplicity or heading toward complexity?

3. When the opportunity arises, ask your parents about your birth. What were some of their feelings about you?

THE PLANT EMBRYO

When sperm cells and egg cells combine in the flower of a plant, a seed begins to be formed. Eventually the new seed begins to form a tiny plant inside itself. This miniature plant formed within a seed is called an *embryo*.

Some of the cells in the seed become the place where food is stored for use when the embryo begins to grow. Other cells form a tough covering for the seed called a seed coat.

In this activity you'll be able to observe the different parts of a seed.

Materials

dried lima beans (you can get these in a grocery store)
sharp knife
hand lens

Directions

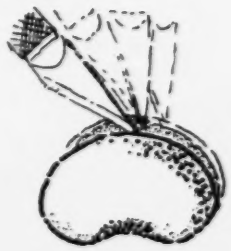
1. Use your hand lens to look at the outside of a dried lima bean. Draw what you see. Do you think there is an embryo in it?

2. Soak a handful of the seeds in a glass of water overnight.

3. On the next day select a few of the seeds that you will want to open.

4. Lay each seed so it looks like this drawing.

5. With your knife, cut the seed coat (covering) along the edge. Be careful not to cut yourself.



6. Open the seed and use your hand lens to try to locate the embryo. Remember, it's going to look very much like a miniature plant.

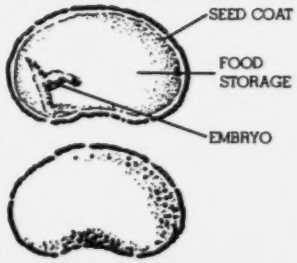
7. Draw what you see.

8. Try to find the following parts of the seed:
seed coat
embryo
food storage area

9. Compare your drawing with this drawing.

10. Open some of the other seeds and compare them to this first lima bean seed.

11. You can plant the other seeds that you have soaked.



A TASTY ACTIVITY FRUITS AND SEEDS

WHEN YOU THINK OF EATING A FRUIT, YOU PROBABLY DON'T REALIZE THAT THE FRUIT OF A PLANT IS REALLY THE PLACE THAT CONTAINS FERTILIZED CELLS OR SEEDS. WE USUALLY JUST EAT THE FLESHY PART OF THE FRUIT THAT IS AROUND THE SEEDS.

IN THIS ACTIVITY YOU'LL BE ABLE TO DISCOVER THE NUMBER OF SEEDS THAT DIFFERENT KINDS OF FRUITS CONTAIN. BY THE WAY, MANY OF THE THINGS WE CALL VEGETABLES ARE REALLY CONSIDERED TO BE FRUITS BY SCIENTISTS.

MATERIALS

FIVE OR SIX FRUITS FROM THE GROCERY STORE, SUCH AS:
ORANGES, GRAPES, CUCUMBERS, TOMATOES, BEAN PODS, PEA PODS, APPLES, AVOCADOS, PUMPKINS, SQUASH.
KNIFE, TRAY, PAPER TOWELS, HAND LENS.

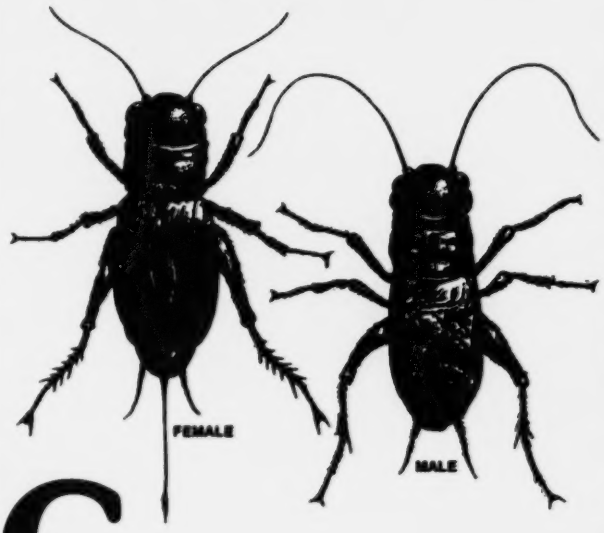
DIRECTIONS

1. CUT OPEN THE VARIOUS FRUITS YOU'VE SELECTED.
2. SELECT ONE SEED FROM EACH PLANT TO STUDY WITH YOUR HAND LENS. MAKE A CHART (OR USE THE ONE PROVIDED) AND DRAW EACH KIND OF SEED. HOW ARE THE SEEDS THE SAME? HOW ARE THEY DIFFERENT?

	KIND OF SEED					
	_____	_____	_____	_____	_____	_____
WHAT DOES IT LOOK LIKE?						

3. COUNT THE NUMBER OF SEEDS IN EACH FRUIT. FOR SOME OF THE FRUITS THAT HAVE MANY SEEDS, COUNT JUST THE NUMBER OF SEEDS IN ONE SECTION AND THEN MAKE A GUESS AT THE TOTAL NUMBER.
4. MAKE A CHART (OR USE THE ONE PROVIDED) AND RECORD THE NUMBER OF SEEDS IN EACH KIND OF FRUIT. WHY DO YOU THINK SOME FRUITS HAVE SO FEW SEEDS AND OTHERS HAVE SO MANY?
5. SAVE THE SEEDS FROM EACH OF THE FRUITS. WASH THE SEEDS FROM EACH OF THE FRUITS THOROUGHLY WITH WATER (NO SOAP) AND PUT THEM IN A WARM PLACE TO DRY. YOU CAN TRY TO PLANT A FEW SEEDS OF EACH KIND TO SEE IF THEY WILL GROW. ALSO, YOU CAN SAVE THE SEEDS TO USE IN AN ART ACTIVITY.
6. HAVE FUN MUNCHING ON THE LEFTOVER PIECES OF FRUIT.

RAISING CRICKETS



Crickets are good animals to study as you explore reproduction. They are easy to get by either catching some in fields or buying them at a fishbait store. They don't require very much care and are easy to feed.

Housing

The best thing to keep crickets in is a large terrarium with a screen cover. If you don't have a terrarium, you can use a styrofoam cooler as the container.

Place about 5 cm of dry soil in the bottom of the container. Since crickets need dry soil, you might think you are all set — but you're not. Female crickets will only lay their eggs in moist soil. How can you have dry soil and moist soil in the same terrarium? It's easy:

Bury a small bowl in the soil so that its top edge is level with the top of the soil. Now fill the bowl with soil and keep it moist. The female crickets will use this bowl as the place in which to lay eggs.

Scatter pieces of shredded paper and short lengths of cardboard tubes (from toweling rolls) on top of the soil. The crickets will use the many nooks and crannies as living and hiding spaces.

Food and Water

The basic food for crickets in a terrarium should be a dry breakfast cereal, such as bran or oatmeal. Every now and then place a piece of apple, potato, or carrot on the floor of the terrarium. The crickets will use this as a source of water. You may also wish to put some damp paper toweling in a small dish and keep this dish in one corner of the terrarium.

Life Cycle

Cricket eggs hatch into nymphs. Nymphs look like small adult crickets except that they don't have wings. The nymphs become adults in less than eight weeks.

Be sure that you have a mixture of male and female crickets to start out your cricket colony. The above drawings should help you tell the difference.

RAISING GUPPIES

Raising guppies is fun for two reasons: (1) They are easy to care for, and (2) pregnant female guppies give birth to live baby guppies. In other words, they do not lay eggs, so you will have a chance of seeing the actual birth of guppies from the mother guppy's body.

The Aquarium or Tank

You will need an aquarium that has a water heater, an air pump, a filter, and a thermometer. If you are going to use an aquarium that hasn't been used for a while, be sure that everything is in working order before you get your guppies. Also, make sure that it is still watertight. If it leaks at the corners or bottom, you will need to buy some aquarium putty at a pet store to use to stop the leaks.

An aquarium that will be a good home for guppies needs all the things you would need to raise any tropical fish: plants, gravel, and so forth. Your pet store salesperson will be able to give you good advice on how to set up your tank. Since baby guppies need to hide to keep safe, be sure to buy plenty of plants for your tank.

The water for your tank should be free of chlorine gas. To get chlorine-free water, you will need to place tap water in wide-mouthed jars and allow them to stand for 48 hours in a warm room. The chlorine will leave the water in this period of time.

Food

You can feed guppies dried fish food that can be bought at any pet store. Guppies also eat small animals such as water fleas that will probably be living in your aquarium.

Male and Female Guppies

Male guppies are smaller than female guppies. Males are usually quite colorful and may have black, blue, white, or orange markings. The male guppy has a long pointed organ that is part of its tail. Sperm go through this organ into the female.

Female guppies are bigger than the male and much less colorful. They are usually all gray, but some have a black spot on their tail. Eggs in the female's body are fertilized by sperm from a male guppy. Pregnant female guppies look as if their underside is swollen.

Baby Guppies

If you do have a pregnant female guppy, you will need to buy something called a "nursery trap," where you can keep her until she gives birth. The tiny babies will leave the trap and swim to safety among the plants. You will need to feed them brine shrimp or special dried food for the first few weeks.

Pregnant female guppies may give birth to as many as sixty babies. It will not be long until you have plenty of guppies in your tank.

MALE GUPPY FEMALE GUPPY

ANIMAL REPRODUCTION:

FROGS

In the spring of the year female frogs lay eggs in streams or ponds. Male frogs release sperm over the eggs as they are laid. When a sperm and egg combine, we say that fertilization has happened.

The fertilized frog eggs look like strands of clear jelly with dark spots. The strands are made of tiny sections, with each section containing one dark spot.

You can study the way in which fertilized frog eggs develop into frogs by providing a good indoor environment for them. This activity should be done in the spring of the year, since that is when the frog eggs are laid and fertilized. It will be easy for you to get fertilized eggs then.

You will need:

frog eggs
aquarium or large glass bowl
1 pound of aquarium sand
hand lens
piece of plastic or glass large enough to cover the top of the aquarium or bowl
aged tap water

Preparing the Aquarium

Add the sand to the bottom of the aquarium or bowl. Prepare some aged tap water by pouring 2 quarts of water into a wide-mouthed jar. Let the water stand for at least two days. This allows the chlorine to escape. Why do you think we need to age the water?

Gathering Frog Eggs

In the spring of the year begin checking the water plants growing at the edges of streams or ponds for frog eggs. When you find some, scoop up about 1 cup of eggs and water using a small container. Also scoop up some of the water plants and green scum you see floating near the eggs. Be careful not to fall into the water!

Carefully add the frog eggs and water plants to the aged tap water in the aquarium. Try to float the green plants and keep as many eggs attached to the plants as possible.

Cover the aquarium with the plastic or glass cover. This will keep the water from evaporating.

Caring for the Frog Eggs

It takes about two or three months for most kinds of frogs to develop from an egg. During this time the egg becomes a tadpole and the tadpole becomes a frog.

Using your hand lens, draw what you see when you look at one part of a strand.

Place the aquarium in a part of the room that gets some sunlight during the day but not enough to heat the water very much. Check the eggs every day and expect to see the eggs become tadpoles in five or six days. Draw the tadpoles that you see.

Getting the tadpoles to grow into adult frogs indoors is hard to do and will take a few months. If you want to try it, follow the steps below. If not, return the tadpoles to the pond or stream that you got the eggs from.

From Tadpoles to Frogs

1. To give the tadpoles an environment that will let them grow into frogs, you will need very few tadpoles. After six tadpoles have appeared, remove the remaining eggs and return them to the stream or pond.

2. Buy some fresh-water fish food at a pet store. Add a pinch of it to the water each day.

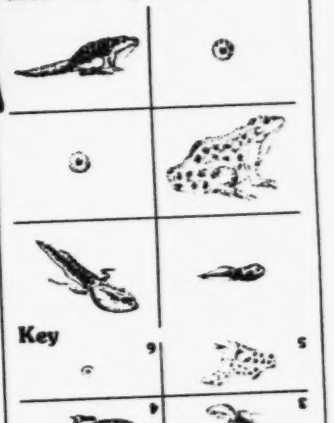
3. If any of the tadpoles die, remove them from the water as soon as possible.

4. If after a month or two you have more than two tadpoles left, return any extras to the pond or stream.

5. Your two tadpoles are well on the way to becoming frogs. Since the frogs will be air breathers, they will need an environment that has a place for them to stay when they are not in the water. Add rocks to the aquarium until you have one part of the tank that is above the water level.

Frog Cycle

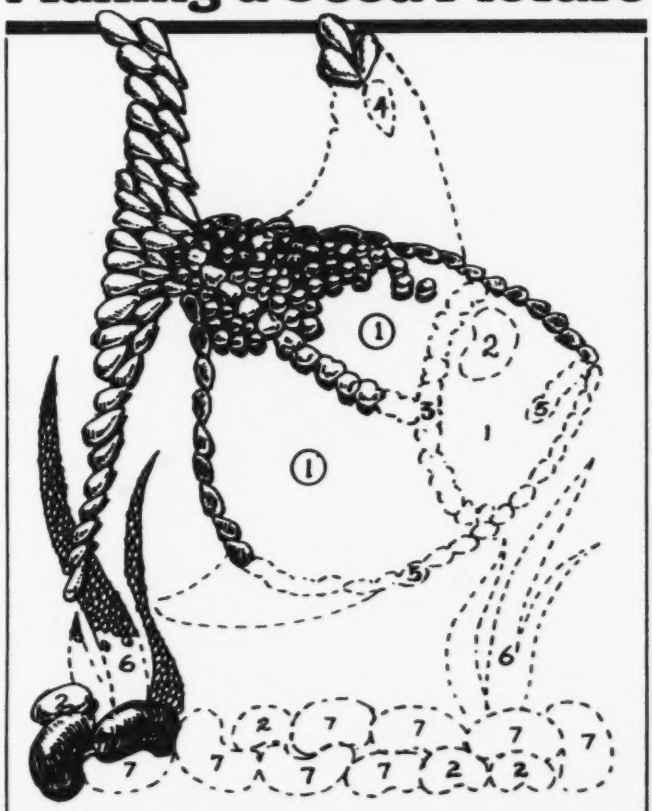
Can you put these cards in order? After you've tried, check the key below.



Why is there an egg at the beginning and end of the pictures? Does the last frog become an egg?

Art ©1968 Regents of the University of California. No endorsement given.

Making a Seed Picture



This is an interesting project that will help you see the artistic side of doing science. A seed picture lets you put together many kinds of seeds to make a picture that has a natural look.

MATERIALS

seeds
rubber cement or paper glue
heavy paper (oaktag or heavy construction paper)
pencil

DIRECTIONS

1. You are going to need a lot of different kinds of seeds in order to make a good seed picture. Here are some ways to get the seeds you need: (a) Use leftover seeds from "A Tasty Activity"; (b) use dried lima beans, peas, kidney beans, and so forth from the grocery or from the kitchen at home or in school; (c) ask a farmer or gardener for leftover seeds; (d) gather some seeds out-of-doors, such as acorns, nuts, or grass seeds.
2. With your pencil, draw a picture on the heavy paper. Try not to make it too complicated. Nature scenes, such as flowers, fish, or animals, will make interesting drawings to use for seed pictures.
3. Put some glue along the most important lines in your picture. Put your largest seeds on these lines.
4. Pick other areas of your picture where each type of seed would look best. Now spread glue over each section and place your other seeds in place.
5. When you are all done, put your picture away for the glue to dry.
6. After the glue has dried, shake the picture so that seeds that weren't glued properly fall off. Check your picture and reglue those seeds that have fallen off.

James Watson
BIOLOGIST

James Watson (1928–), an American biologist, is the codesigner of the famous twisted-helix model of the DNA molecule. He and Francis Crick of Great Britain, in a brilliant display of insight, constructed the model on the basis of the research findings of Maurice Wilkins, a British biophysicist. Crick, Watson, and Wilkins shared the 1962 Nobel Prize in physiology and medicine in recognition of their work with DNA. Watson, a professor of biology at Harvard University, studied at Indiana University and at the University of Chicago.

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FRANCIS H. C. CRICK, PHYSICIST AND BIOLOGIST

Francis Crick (1916–) of Great Britain worked with James D. Watson in building a model of the DNA molecule. Although he now is recognized as a biologist, Crick began his work in science as a physicist. He began his research into molecular biology at Cambridge University in 1949. The famous model of the DNA molecule is known among scientists as the Watson-Crick model.

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ONE TO TANGO
ASEXUAL REPRODUCTION

Not all living things need both male and female cells to combine in order to produce new living things. In this activity you will be able to get certain kinds of plants to grow from parts of the original plant and not from seeds.

Materials

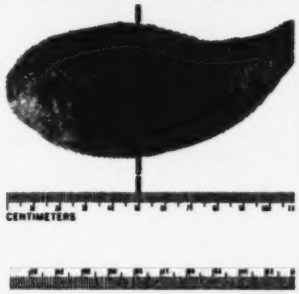
knife
bag of vermiculite or sand (you can get vermiculite in any plant store)
sweet potato
carrot
white potato
three planters, flowerpots, bottom halves of milk containers, or large plastic cups
clear plastic bags
pebbles

Directions

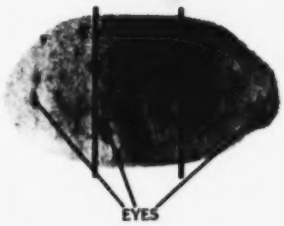
1. Place the pebbles in the bottom of the containers. Add the vermiculite or sand in the three planters. Add water to the containers until the sand or vermiculite is thoroughly moistened.

2. Find a healthy-looking carrot and measure off about 2 cm (less than an inch) from the top. Carefully cut through the carrot at this point. Watch your fingers.

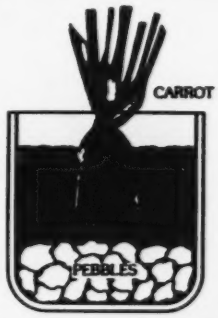
3. Cut about 5 cm (about 2 inches) from the top of a sweet potato. Measure from the flattest end of the potato.



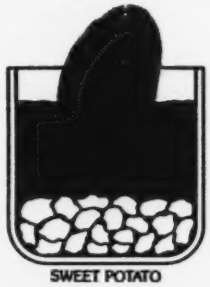
4. Cut the white potato and find the parts called "eyes." Cut the potato into three sections that are each at least 5 cm (2 inches) long. Make sure that each section has at least one "eye."



5. Plant the carrot section in one planter so that just the top can be seen above the surface.

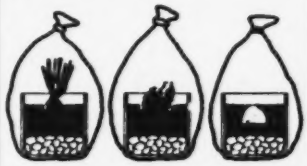


6. Plant the sweet potato section in another container and leave the top uncovered.



7. Plant the white potato sections in a container so that they are completely below the surface.

8. Put each container in a plastic bag and fasten the top of the bag so that no air can get in or out.



9. Check the three planters every other day for about three weeks. Keep track of what you see on the chart below.

10. After three weeks open the bags and carefully remove the planters. You can keep these plants alive by transplanting them into containers that have potting soil in them.

WHAT DID YOU OBSERVE?

Date	Carrot	Sweet Potato	White Potato

LUTHER BURBANK, PLANT BIOLOGIST

One famous American scientist, Luther Burbank, devoted his life to the improvement of plants and the development of new plants. Burbank had little formal education, but he had the instincts for scientific research and for applying the scientific method to his work. He lived from 1849 to 1926.

In his gardens and laboratories in California, Burbank developed many hybrids. [A hybrid is the name we give to a plant or animal that results from the mating of two different species.] He patiently observed the development of a plant through many generations. He experimented with both fruits and flowers.

Burbank employed both crossing and selection to produce his hybrids. *Crossing* is the combining of two plants to grow a third. *Selection* is the use of only the best plants. The inferior ones are cast aside.

Among famous Burbank developments are the plumcot and the white blackberry. The *plumcot* is a cross between a plum and an apricot. The plumcot may be yellow, pink, white, or crimson. Burbank's white blackberry is transparent. Its seeds are unusually small.

Burbank also developed the *pomato*, which is a cross between a potato and a tomato. The pomato looks like a small tomato, but it grows on a potato vine.

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CHAPTER 4

LIVING THINGS

WHAT ABOUT THE ANIMALS?

A tiny ant climbing a large, rough-barked tree, a coconut swinging from a beautiful palm tree, a hungry shark quietly cruising toward a smaller fish that looks like a possible lunch, and a jungle elephant taking giant-sized nibbles from a tree branch all have something in common with you — they are alive.

Their relatives were here millions of years ago, and we hope their parade of life stretches out for many millions of years into the future. But will it?

Life on Earth is abundant, diverse, and widespread. There is no other planet in the solar system that we are sure contains life, and as yet we have no evidence that life exists elsewhere in the universe. But more remarkable than this is the fact that life on Earth is quite uniform. Some biologists have suggested that all life on Earth may have originated from a single cell, sparked into life by a lightning bolt in the Earth's early atmosphere.

Fossils have helped scientists understand ancient life on Earth. Evidence in the fossil rocks indicates life may have begun over 3 billion years ago.

The model of evolution suggested by Charles Darwin and Alfred Wallace in the nineteenth century has helped explain the origin of the hundreds of plant and animal species that live on the planet Earth. Evolution is a continuing process. We can only guess about what life on Earth will be like in the future. The activities and ideas in this section will bring you closer to an understanding of life on Earth.

HOW DOES THIS PICTURE MAKE YOU FEEL? HUMAN BEINGS HAVE MADE WILD ANIMALS INTO PETS AND HAVE BUILT ZOOS THAT HAVE REMOVED ANIMALS FROM THEIR NATURAL ENVIRONMENTS. SOME ZOOS HAVE TRIED TO CREATE ENVIRONMENTS SIMILAR TO THE ANIMALS' NATURAL HOMES. ONE WAY TO GATHER MORE INFORMATION ON HOW ANIMALS ARE TREATED IS TO CONDUCT A SURVEY OF YOUR NEIGHBORHOOD AND THE LOCAL ZOO. HERE ARE SOME QUESTIONS YOU MIGHT ASK.

FOR A NEIGHBORHOOD SURVEY

(1.)
HOW MANY FAMILIES IN YOUR NEIGHBORHOOD HAVE PETS? (DEFINE THE SIZE OF THE NEIGHBORHOOD ANY WAY YOU WISH.)

(2.)
WHAT IS THE CONDITION OF THE ANIMALS AS YOU OBSERVE THEM?

(3.)
DO YOU OBSERVE ANIMALS ROAMING ABOUT YOUR NEIGHBORHOOD, OR ARE THEY KEPT IN THEIR OWNERS' YARDS OR HOMES?

(4).
CHECK WITH YOUR LOCAL HUMANE SOCIETY AND ASK SIMILAR QUESTIONS.

FOR A SURVEY OF THE ZOO

(1.)
DO THE ANIMALS HAVE ENOUGH SPACE IN WHICH TO MOVE ABOUT?

(2.)
ARE THE ANIMALS USUALLY KEPT IN CAGES?

(3.)
IS THE ENVIRONMENT OF THE ZOO SIMILAR OR DIFFERENT FROM THE ANIMALS' NATURAL ENVIRONMENT?

THE PARADE OF

Table 1 Geological Time Scale

ERA	PERIOD	EPOCH	EVENTS IN THE HISTORY OF LIFE	OTHER IMPORTANT EVENTS
CENOZOIC	Quaternary	Recent (10,000)	Modern horse evolves in North America, then dies out	Ice Ages
		Pleistocene (1,000,000 to 2,000,000)	Earliest man	Grand Canyon carved
	Tertiary	Pliocene (11,000,000)		
		Miocene (25,000,000)	Rapid spread and evolution of grazing mammals	
		Oligocene (40,000,000)	Earliest elephants	
		Eocene (60,000,000)	First primitive horses, rhinoceroses, and camels	
		Paleocene (70,000,000)	First primates	
MESOZOIC	Cretaceous (135,000,000)		Extinction of dinosaurs Great evolution and spread of flowering plants	Dinosaurs Half of North America covered by seas
	Jurassic (180,000,000)		First birds and mammals Dinosaurs at their peak	
	Triassic (225,000,000)			Arid climates in much of western North America
PALEOZOIC	Permian (270,000,000)		Mammal-like reptiles	Ice Ages in Southern Hemisphere World climate much like today Deserts in western United States
	Pennsylvanian (308,000,000)		First reptiles	Large insects Widespread swamps, coal source Tropical climate in United States
	Mississippian (360,000,000)			Widespread flooding of North America, limestone deposited
	Devonian (400,000,000)		Sharks abundant First amphibians First forests	Trilobites
	Silurian (440,000,000)		First air-breathing animals (scorpions) First land plants	Deserts in eastern and central U.S.
	Ordovician (500,000,000)		Trilobites at peak First vertebrates (fish)	
	Cambrian (600,000,000)		Marine shelled invertebrates common First abundant animal fossils	
PRECAMBRIAN PROTEROZOIC	(2,500,000,000)		Marine invertebrates probably common; few with shells (1,200,000,000)	Glaciation — probably worldwide
ARCHEOZOIC	(4,500,000,000)		Earliest plants (marine algae) (3,200,000,000)	Numbers refer to time in years B.P. (before present) since the beginning of the era, period, or epoch.

Based on "Calibrated Geologic Time Scale" in *Investigating the Earth* Teacher's Guide, © 1984 American Geological Institute, published by Houghton Mifflin. No endorsement given.

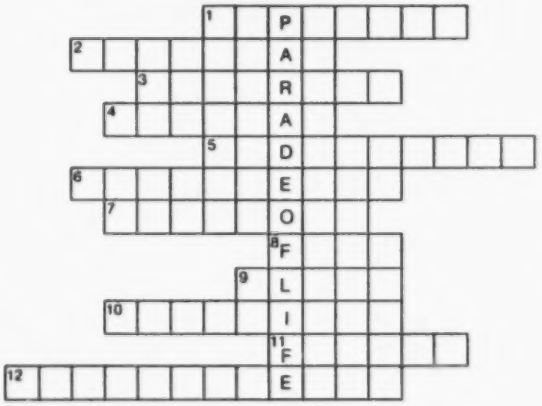
LIFE ON EARTH

The best estimates indicate that Earth is about 4.5 billion years old. No one knows for sure when life began, but simple bacterialike organisms have been found in rocks 3 billion years old. Life that existed on Earth during its earlier history did not leave us much of a record. We see very little evidence in the rocks.

The parade of life appears to have begun about 600 million years ago with the evolution of plants and animals proceeding quite rapidly. During this time of evolution, Earth itself went through many changes, such as invasion of the land by the oceans, uplift of mountains, erosion, and several ice ages. Some forms of life were not able to survive these and other changes and became extinct. Fortunately, they left behind traces of their existence in the form of fossils. These traces and the study of rock formations have allowed geologists and biologists to put together a general picture of the parade of life. This picture is presented as a time scale in Table 1.

To help you become familiar with the scale, we have provided some games and puzzles based on it.

PARADE OF LIFE PUZZLE



FIND THE TERM THAT FITS EACH DEFINITION. ENTER THE NAME IN THE CORRECT BLOCKS.

1. ANIMALS THAT ARE MAMMALLIKE AND LIVED DURING THE PERMIAN.
2. FIRST AMPHIBIANS AND FORESTS OCCURRED DURING THIS PERIOD.
3. PERIOD OF FIRST ABUNDANT FOSSILS.
4. PERIOD WHEN ICE AGES OCCURRED IN SOUTHERN HEMISPHERE.
5. TRILOBITES WERE AT THEIR PEAK IN THIS PERIOD.
6. PERIOD WHEN DINOSAURS BECAME EXTINCT.
7. ERA DURING WHICH THE DINOSAURS LIVED.
8. NAME OF THE FIRST VERTEBRATE ANIMALS.
9. NAME OF THE EARLIEST PLANTS.
10. NAME OF THE FIRST AIR-BREATHING ANIMALS.
11. TRACE OR EVIDENCE OF PREHISTORIC LIFE.
12. EPOCH DURING WHICH EARLIEST MAN EXISTED.

ANAGRAMS

Each of these scrambled words is the name of a period or era in the geological time chart. Can you name one thing that happened in each period or era?

APLOECOIZ
NCABMIAR
NAIPISPSIMISS
SSUJRACI
TRYANQAUR

Answers: PALEOZOIC, CAMBRIAN, MISSISSIPPIAN, JURASSIC, QUATERNARY

Name	Happening

Each of these scrambled words is the name of an animal. What do they have in common and when did they live?

TSEPMRAI
TPEHLENAS
ANM
SCLMAE
SHSERO

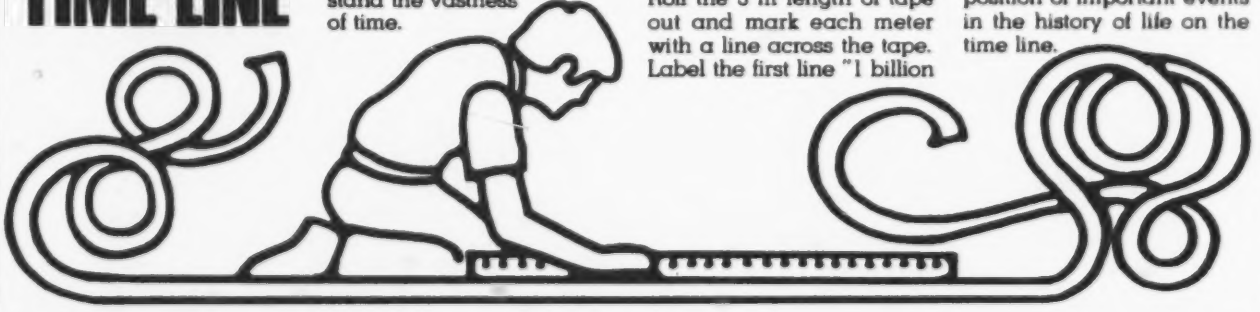
Answers: PRIMATES, ELEPHANTS, MAN, CAMELS, HORSES
They are all mammals from the Tertiary Period.

ANSWERS

1. REPTILES
2. DEVONIAN
3. CAMBRIAN
4. PERMIAN
5. ORDOVICIAN
6. CRETACEOUS
7. MESOZOIC
8. FISH
9. ALGAE
10. SCORPIONS
11. FOSSIL
12. PLEISTOCENE

MAKING A TIME LINE

From Table 1 it is evident that the Earth is very old and that life has been parading for a long time. Here's an activity to help you appreciate and understand the vastness of time.



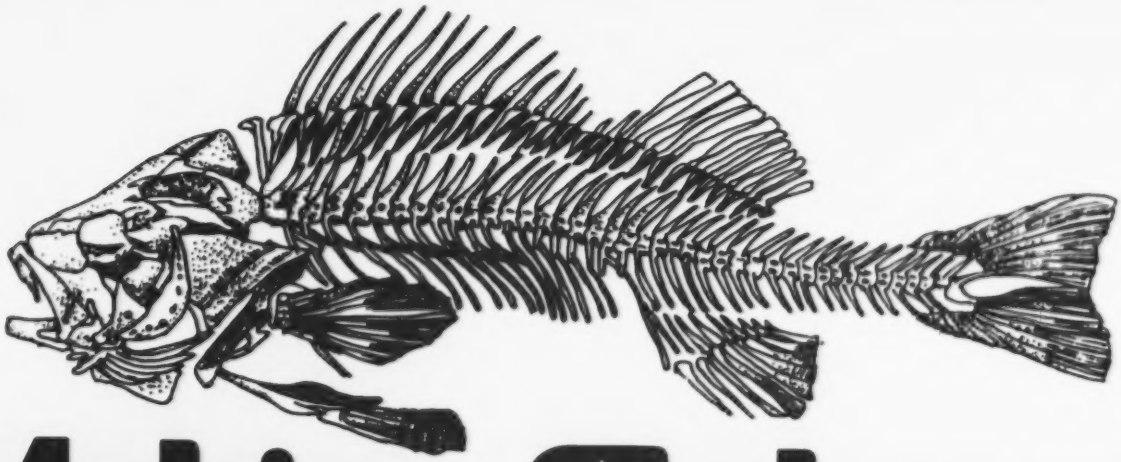
MATERIALS

5 m of adding machine tape
meterstick
pencils or crayons

DIRECTIONS

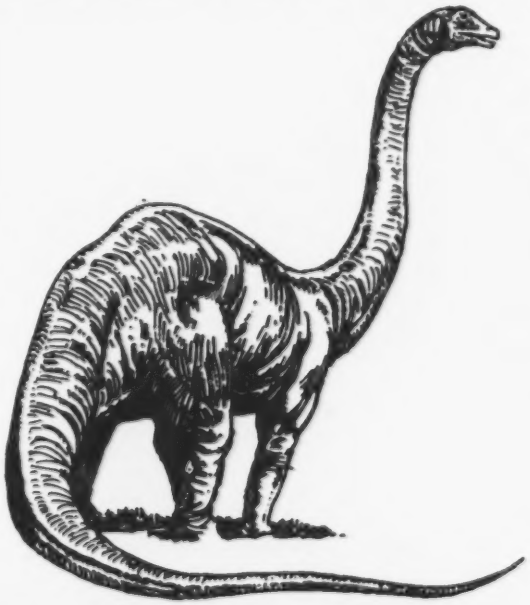
Roll the 5 m length of tape out and mark each meter with a line across the tape. Label the first line "1 billion years ago," the second line "2 billion years ago," and so forth. The end of the tape will be "5 billion years ago."

Use Table 1 and mark the position of important events in the history of life on the time line.



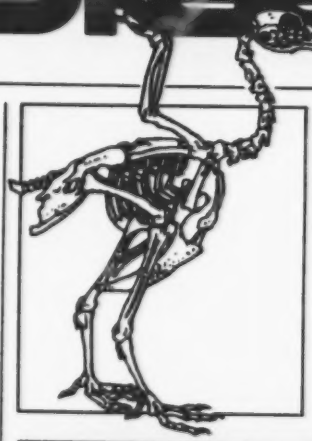
Making Skeletons

Much of what we know about life on Earth has been learned from an animal's hard parts. Many animals wear shells that protect the animal from the environment and from its predators. We can learn much from animals by examining skeletons. The drawing shown here is of an extinct animal, the dinosaur. What can you tell about this animal from the drawing? What do you think the skeleton looks like?



You can make your own skeleton models very easily from a small animal, such as a dead chicken, a rabbit, or a fish. Here's how you might go about this activity:

1. Cook (boil) the animal you are going to assemble a skeleton from. One animal for about two or three people is sufficient. You'll have more fun and you'll learn more if you eat the meat as you take each bone out.



2. Lay the bones out on a tray or a large piece of cardboard. Glue and label each of the bones as you work. (You may find bones missing if you used a chicken. You may not have lower legs, feet, head, or neck. If so, try drawing them in.)

DO ALL ANIMALS HAVE SKELETONS?

Did you ever wonder about whether all animals have skeletons? Here's a way to find out.

Cook a variety of animals such as clams, shrimp, squid, lobsters, crabs, small fish, and frogs. With paring knives and scissors, prepare to dissect each of them.

You should work with a small group of people and each group should have one of each animal type. You might try the following:

(1.)
Identify the location of the animals' hard parts (inside, outside, no hard parts).

(2.)
Arrange the hard parts of each animal on a large poster board. Glue the hard parts on the poster board and label them.

(3.)
Look for special features of each animal.

(4.)
Have salt and pepper available and enjoy eating the cooked food that you like.

THE ZERO GAME

All of the dates given in the table on page 28 have many zeros. In this quiz you are to decide how many zeros to add to the number given in each statement.

1. The Paleozoic began 6 _____ years ago.

2. The first reptiles appeared 305 ___ years ago during the Pennsylvanian period.

3. The earliest elephants occurred during the Oligocene 4 _____ years ago.

4. The first abundant animal fossils appeared during the Cambrian about 6 ___ years ago.

5. The Grand Canyon was eroded (carved) starting about 25 ___ years ago.

NATURE BOOKS

Animal Life in the Antarctic by F. D. Ommanney. New York: McGraw-Hill, 1971, $4.33.

Because of a Flower by Lorus and Margery Milne. New York: Atheneum, 1975, $6.95.

Concise Color Encyclopedia of Nature by Michael Chinery. New York: Crowell, 1972, $7.95.

Deserts by Maurice Burton. Levittown, N.Y.: Atlantic Arts, 1974, $6.75.

Land Alive by Ronald Rood. Brattleboro, Vt.: Stephen Greene Press, 1975, $4.50.

Life on a Giant Cactus by Patricia Lauber. Champaign, Ill.: Garrard, 1974, $3.48.

Nuts from Forest, Orchard, and Field by Gray Johnson Poole. New York: Dodd, Mead, 1974, $4.95.

BOOKS ON ZOOS

Doctor in the Zoo by Bruce Buchenholz. New York: Viking, 1974, $10.95.

Zoos Are News — Conservation or Extinction? by Cyril Bracegirdle. New York: Abelard-Schuman, 1972, $5.95.

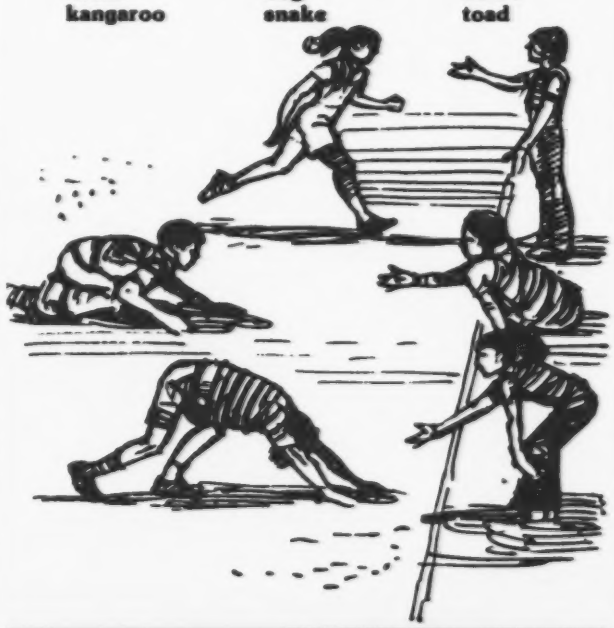
TORTOISE AND HARE RELAY RACE

This game is designed for teams of four players, although as many teams as you wish may play.

Give each team identical sets of cards. Each set contains four cards, and the name of an animal is written on each card. Each player should draw a card. During the relay race each player must run (or crawl or roll or jump) as the animal does.

Set up a track so that each person races at least 50 meters. The simplest arrangement is to line up the players from each team at the starting area. Each player must run, jump, or crawl to the other end of the track and then race back to tag the next player in line. The first team with all animals back wins. Here are some interesting sets of animal cards that you might wish to use. Remember, one set per race.

SET 1	SET 2	SET 3
tortoise	human	lobster
hare	gorilla	penguin
worm	dog	horse
kangaroo	snake	toad



BOOKS ABOUT PREHISTORIC LIFE

Album of Prehistoric Animals by Tom McGowen. Chicago: Rand McNally, 1974, $4.95.

Dinosaurs and All That Rubbish by Michael Foreman. New York: Crowell, 1973, $4.95.

Fossils Tell of Long Ago by Aliki. New York: Crowell, 1972, $3.75.

How Did Life Get There? by Daniel Cohen. New York: Julian Messner, 1973, $5.50.

The Long-Lost Coelacanth by Aliki. New York: Crowell, 1973, $3.75.

To Find a Dinosaur by Dorothy F. Shuttlesworth. New York: Doubleday, 1973, $4.95.

When the Dinosaurs Disappeared — Mammals of Long Ago by Rosalie Davidson. Chicago: Childrens Press, 1973, $3.79.

THE GREAT SPECIES RACE

This game will bring on a lot of laughs. But it also is great for learning how various animals move.

Establish a race track at least 50 m long. Line all the players up in a straight line. The player directing the game calls out the name of an animal, such as "duck." Everyone must race to the end of the track like a duck. The first one there is the Great Duck.

The list of animals is endless. Here are a few to get you started: snake, worm, fish, bird, dog, amoeba, horse, kangaroo, and turtle.

As a variation, see what kind of game develops when you ask the players to race or move as any of the following: rock in a stream, air, leaf, water, branch on a tree.

THE PREDATOR & PREY GAME

This is a game that illustrates one aspect of the concept of natural selection, or survival of the fittest. It shows that through evolution some animals have developed changes in colors, allowing a greater chance for survival against their predators. The game is best played outside.

(1.)
Dye at least 200 toothpicks red and 200 green. Randomly distribute equal numbers of these in a green vegetation area and in a brown dirt area of about the same size.

(2.)
The toothpicks represent insect prey, while people represent insect predators. In the green area, tell the "predators" to collect as many prey as possible in 30 seconds. Record the number of green and red prey collected (use the tally card). Repeat these 30-second trials until all the prey are gone.

(3.)
Repeat this collection procedure in the brown dirt area.

(4.)
Compare the number of trials necessary to collect all the prey. Which prey do you think has the better chance for survival? In what type of environment?

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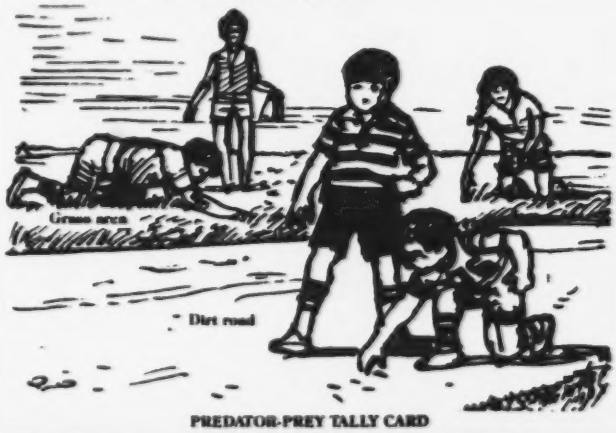


PREDATOR-PREY TALLY CARD

SECONDS	GREEN AREA RED	GREEN
1ST 30		
2ND 30		
3RD 30		
4TH 30		
5TH 30		

SECONDS	BROWN AREA RED	GREEN
1ST 30		
2ND 30		
3RD 30		
4TH 30		
5TH 30		

BOOKS ON BEARS, BEES, BEAVERS, AND OTHER CRITTERS

Animal Homes by Sally Cartwright. New York: Coward, McCann and Geoghegan, 1973, $3.86.

Beavers by James Poling. New York: Franklin Watts, 1975, $3.90.

Cockroaches by Joanna Cole. New York: Morrow, 1971, $3.75.

The Common Insects of North America by Lester A. Swann and Charles S. Papp. New York: Harper & Row, 1972, $15.00.

The Fantastic World of Ants by Herbert Molloy Mason Jr. New York: McKay, 1974, $5.95.

Frogs as Wild Pets by Loverne Morris. Chicago: Childrens Press, 1973, $5.85.

A Gerbil for a Friend by Donna Lugg Pape. Englewood Cliffs, N.J.: Prentice-Hall, 1973, $4.95.

Hooved Mammals of the World by Ugo Mochi and T. Donald Carter. New York: Scribner's, 1971, $9.95.

How Animals Work for Us by Robin and Jocelyn Wild. New York: Parents' Magazine Press, 1973, $4.95.

Insects and Their Young by Ross E. Hutchins. New York: Dodd, Mead, 1975, $5.50.

Let's Find Out About Bees by Cathleen Fitzgerald. New York: Franklin Watts, 1973, $3.75.

Let's Look at Reptiles by Harriet E. Huntington. Garden City, N.Y.: Doubleday, 1973, $5.95.

The Life of Insects, The Life of Fishes, The Life of Birds by Maurice Burton. New York: Western Publishing, 1974, $4.95 each.

The Life of Meat Eaters by Maurice Burton and Robert Burton. New York: Western Publishing, 1974, $4.95.

Only Birds Have Feathers by Katharine W. Mosely. Irvington-on-Hudson, N.Y.: Harvey House, 1973, $3.95.

Vultures by Ann Warren Turner. New York: McKay, 1973, $7.95.

What Is That Alligator Saying? A Beginning Book on Animal Communication by Ruth Belov Gross. New York: Hastings House, 1972, $4.95.

Wonders of the World of Bears by Bernadine Bailey. New York: Dodd, Mead, 1975, $4.95.

MAKING FOSSILS

Scientists who collect fossils are known as *paleontologists*. The fossils they find are usually millions of years old. They use them to help unravel the past and to figure out what life was like way back then. In this activity you are going to make fossils and then see what other people can learn from observing them.

MATERIALS

two cardboard or aluminum pie pans
plaster of Paris
variety of small objects (leaves, snails, shells, nails, pins, coins, buttons, twigs, stones, seeds, etc.)

DIRECTIONS

(1.)
Mix the plaster of Paris with water to form a pasty mix. Pour into both pans.

(2.)
Press the objects in the plaster of Paris to form impressions. Remove the objects as the plaster hardens. Here are some possible things you can do:

(a.)
Make tracks representing some animal(s). See if others can deduce what happened.

(b.)
Make plant and animal impressions and have people make deductions about them.

(c.)
Invent fossil impressions made by an extinct group of people in the past. Have others determine what the impressions represent and let them try to learn what these people were like.

Based on "Making Fossils," from ESSENCE II, Addison-Wesley Publishing Co., Menlo Park, California. © 1975 American Geological Institute. Used with permission.

HOW MUCH VARIATION?

One important characteristic of life on Earth is the variation that exists in every species. Just look at brothers and sisters, dogs, cats, horses, peas, roses, and marigolds. Sometimes the variation is slight and therefore not obvious. In this activity you will study variation among people you know and then among some other species.

Based on "How Much Variation," from ESSENCE II, Addison-Wesley Publishing Co., Menlo Park, California, © 1975 American Geological Institute. Used with permission.

PEOPLE VARIATION

Obtain sheets of butcher paper, measuring tapes, metersticks, crayons, and several students your age (the more the better).

(1.)
Have someone trace your body carefully, paying attention to details such as fingers, arm length, and so forth. List the following measurements on the butcher paper: arm, leg, and finger lengths; thickness of arms and legs; waist size; head size; foot width.

(2.)
After measuring every aspect of each person, determine the average size of each measurement. Using this information, construct the "average person." This can be done by making full-scale drawings of front view, side view, and back view. Now compare yourself to this average person and determine how much *variation* you represent from the "average." (If you are really ambitious, try constructing a three-dimensional model of a Mr. or Ms. Average, using papier-mâché and plaster of Paris.)

VARIATION IN OTHER THINGS

For this activity you will need a whole bunch (about 100) of the *same* species (leaves from the same plant, beans from the same package, flowers from the same plant). You can also use another kind of "species" (combs, notebooks, purses, shoes).

When you have the objects assembled (for example, 100 leaves), carry out the following:

(1.)
Arrange the individuals in some order and then determine and describe the range of variation. List the characteristics you used to arrange the individuals.

(2.)
Reexamine the species and determine some additional characteristics that you could use to arrange or group them.

(3.)
If someone asked you to describe the average individual in the species you are examining, what would you say?

THE LIVING GAME

DID YOU EVER TRY TO ACT OUT THE BEHAVIOR OF A PLANT OR AN ANIMAL? HERE'S A GAME IN WHICH YOU PANTOMIME VARIOUS ANIMALS AND PLANTS.

THE CARDS TO PLAY THIS GAME ARE LOCATED IN THE "GAMES AND OTHER NIFTIES" SECTION OF THE BOOK.

THE ORIGIN OF THE SPECIES: WHOSE IDEA?

You have probably heard of Charles Darwin. He developed the theory of evolution to explain the origin of species. Alfred Wallace also developed the same theory of evolution at about the same time, but independently of Darwin! Both of these men were naturalists, and both spent a great part of their lives collecting and studying specimens of both plants and animals.

While he was in his early twenties, Darwin was asked to be the naturalist on a ship that was to chart the coast of South America. For five years he was amidst birds, flowers, trees — all sorts of animals and plants. After he returned he read a report on population by a man named Thomas Malthus. After reading the paper, the idea to explain population growth and the evolution of species flashed into his mind. Four years later (1842) he finally wrote about it, but it wasn't until 1859 that he published anything about his theory. He probably would never have done so if it hadn't been for Alfred Wallace.

Alfred Wallace left school at age fourteen. He became a surveyor, but he spent the major portion of his life collecting rare plant and animal specimens, which he then could sell in England. Wallace spent four years (1848–1852) in South America collecting specimens and observing plants, animals, and the Amazon natives. The time that he spent in the forest led him to ask questions about the many different species that he was observing. During his return the ship on which he was traveling burned and he lost most of his specimens. But he was the type of person who never gave up. He set off for the Far East for eight years. In 1858 he became ill on an island. After a night of fever, he had a flash of inspiration, recalling the same paper (by Thomas Malthus) that Darwin had read. That flash was an explanation for the origin of the species. He immediately wrote about this in the form of a brief paper, which he sent to Charles Darwin.

Darwin was shocked to read Wallace's paper, but this forced him to reveal his own work. (He had told his wife to publish his work only after he died.) Darwin published The Origin of Species *in 1859, and it made him famous.*

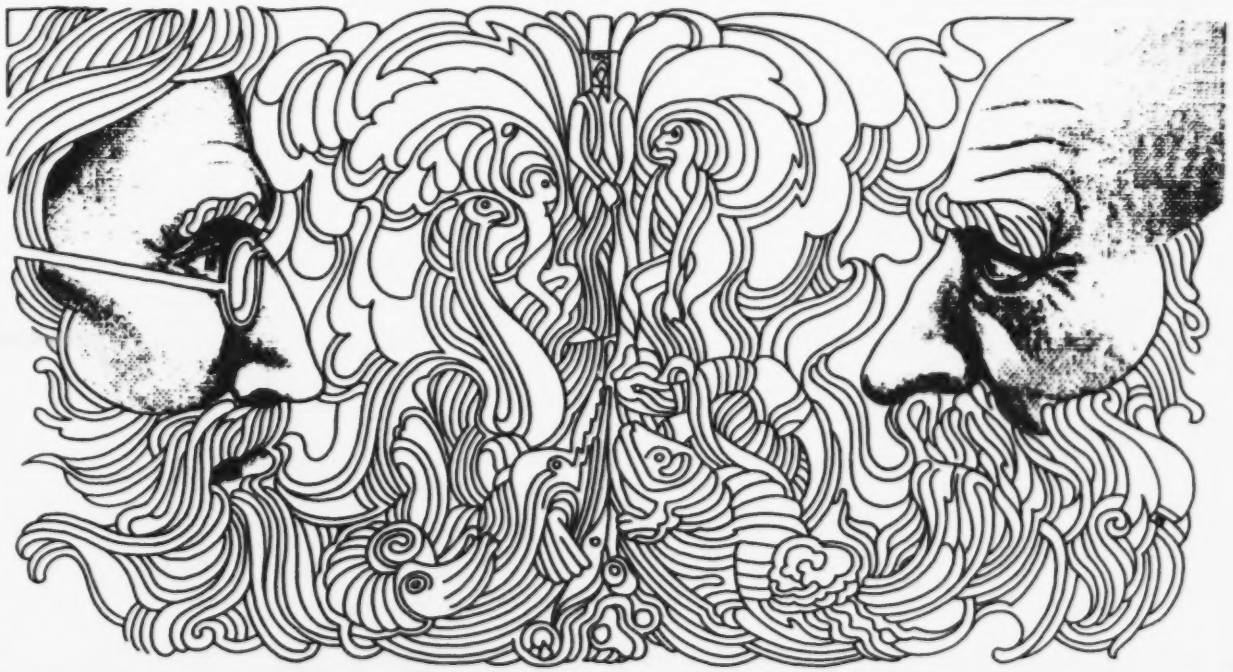
1. Check the library for a book on Charles Darwin. Try to find out what type of personality he had that would cause him not to want to publish his discoveries. Read about Wallace, too. How do their personalities compare?

2. Often we think that scientists arrive at discoveries by very logical means. Here we see that both Wallace and Darwin came up with the same idea under unusual conditions: Wallace when he was ill and Darwin when he was reading for pleasure. Find out what you can about the subject of creativity. Have other inventions and ideas been discovered in similar ways?

3. Do you seem to come up with good ideas when you're relaxed (just before going to sleep, sitting alone in a field)? Find out how others respond to this question.

CHARLES DARWIN

ALFRED RUSSELL WALLACE



THE TREE OF LIFE

Each one of us has a heritage. We are each the result of the evolutionary process. Our uniqueness is the result of the genetic traits that are passed on from one generation to another and of our life experiences. The "Tree of Life" is a two-part activity. In the first part you will trace back as far as you can to find the names, locations, and a few characteristics of your parents, grandparents, your great-grandparents, your great-great-grandparents, and so forth. In the second part you will examine your life experiences.

Part One

Obtain a large sheet of poster paper or butcher paper. Sketch out a "Tree of Life," as shown below.

Each block should include the following information: name, place and date of birth, occupation, characteristics. For example,

John Smith
Boston, Mass. (1901)
Railway Engineer
6'2" tall, red hair, blue eyes

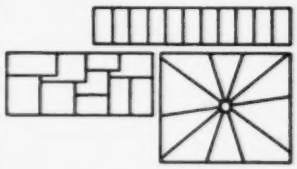
Your task will be to create your personal tree. Your sources of information will be your parents, your grandparents, other relatives, and record offices in local health departments. Try to include photographs for your parents and for as many grandparents and great-grandparents as you can. (Don't be disappointed if you can't find **all** the information needed to complete the chart.)

Notice that on the chart we've only included blocks for four generations into your past. In just four generations thirty individual humans have passed on characteristics and traits (through their genetic material) to you. With this in mind, here are a few questions and problems for you to consider after you have completed your chart:

1. List some of your traits, such as color of hair, color of eyes, tone of skin, shape of nose, height, weight, size of earlobe. Which of these traits can you trace back in your "Tree of Life"?
2. Which of your traits do you think were passed on to you from your father? Which from your mother?
3. If you have brothers or sisters, what are some traits that you have in common?

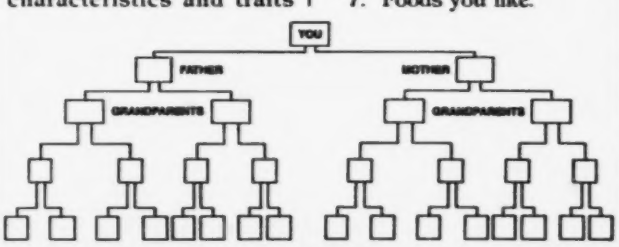
Part Two

Collect as many old magazines and newspapers as you can. You will also need scissors, glue, a felt-tip pen, and a piece of butcher paper. Divide the butcher paper into sections equal to your age in years. You can do this in a variety of ways, as shown here.



Using pictures cut out of the magazines, make a poster about yourself. Focus on your experiences and on the things you liked to do for each of the years on the butcher paper. You should use the pictures to indicate things such as:

1. Where you have lived.
2. Friends you have made.
3. Places you have visited.
4. Schools you have gone to.
5. Interests (and when they developed).
6. Hobbies.
7. Foods you like.



GEORGE WASHINGTON CARVER, STUDENT OF NATURE

George Washington Carver (1864–1943) knew much about nature's ways when he started out seeking an education as a nine-year-old boy. He was a black boy without parents or money, seeking answers to the questions that come from keen senses.

Young Carver understood how animals and plants depend on one another. He knew also that people must trust and depend on other people. Stories of how Carver helped others can be found in the many books about his life. He would surely want you to know also of the people who helped him. His life was brightened by the teachers, fellow students, and many friends he made wherever he went. At one time, a man sold him a washboard and tub on credit so that he could start a laundry in Indianola, Iowa. At Indianola, he attended Simpson College, where he learned of nature, art, and music as he earned his keep in his laundry.

Flower bulbs became an absorbing hobby for Carver. He crossed plants to produce flowers of new and unusual colors and sizes. While he was at Iowa State University, he became an expert in mycology (the study of molds and fungi) and systematic botany. His fame with plants came to the attention of another famous black American, Booker T. Washington. He offered Carver a position at the Tuskegee Institute in Tuskegee, Alabama. Here Carver's contributions to a better life included more than 300 products that could be made from peanuts. These inventions and many others he gave freely to advance the agriculture of the southern United States. For more than forty years Carver walked nature's roads both in and out of the laboratories of Tuskegee Institute.

Carver looked to science as a way of improving the lives of people. His goal was a life in harmony with nature, where wildflowers, rocks, and birds would flourish for people of all ages.

The life of George Washington Carver was abstracted from *People, Concepts, Process, Science 5* by Holmes et al., © 1974 Webster Division, McGraw-Hill Book Co. pp. 312 through 315. Used with permission.

CHAPTER 5

MAGNIFICENT YOU

Across an open field
Running and laughing
Racing toward a friend
Faster and faster
With your heart pounding.
Running faster and faster,
Suddenly tripping on a rock,
Falling down, down . . .

Breaking your fall by putting
out your hands in a split second.
Your hands get bruised,
But you're O.K.

Laugh at yourself.
Pick yourself up,
And start running again.

TIRED MUSCLES

In this activity you'll be able to see how fast some of the muscles in your body tire out when you put them to work. The word "fatigue" is sometimes used to describe this tiring out of muscles. If muscles seem to get fatigued too quickly, it may mean that they are not getting enough exercise.

You will need a book, a clothespin, and a clock or watch with a second hand.

Use a chart like the one on this page to record the results of the following muscle fatigue experiments. You can do this experiment by yourself or with others.

Finger Fatigue

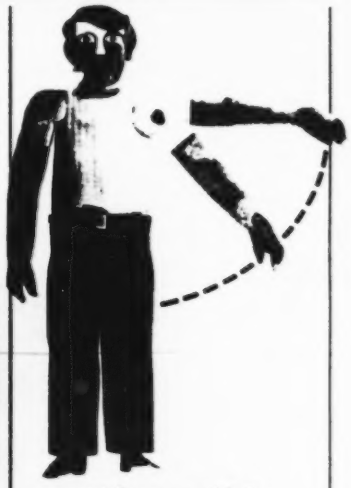
Pick up the clothespin and hold the ends between your thumb and index finger. Now find out how many times you can open and close the clothespin in 30 seconds. Be sure to open the clothespin completely each time you squeeze the ends together. Do this experiment three times and record your data on the chart.

Hand Fatigue

Put your arm on the table with the palm of your hand facing up. Now find out how many times you can make a fist in 30 seconds. Be sure to open your hand completely and then form a tight fist each time.

Arm Fatigue

Pick up a book and stand with the hand holding the book hanging straight down. Find out how many times in 30 seconds you can lift the book to shoulder height. Keep your arm straight as you lift the book.



Here is a chart you can use for the information:

NAME	FINGER	HAND	ARM

1. *Do you get better or worse each time you repeat the experiments?*

2. *Do you observe any differences between girls and boys on these fatigue experiments?*

3. *What could you do to improve the strength of the muscles that you tested?*

THE EFFECTS OF SOME MAKE-BELIEVE DRINKING

Many people have a problem because they drink too much alcohol. By drinking too much they not only damage their body but also they can hurt other people if they try to drive a car or truck or operate machinery in a factory. In these experiments you'll be able to discover what too much alcohol can do to your judgment and reaction time *without really drinking any alcohol.*

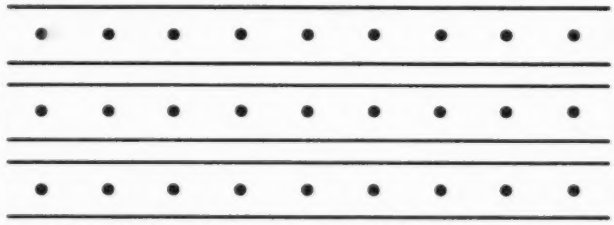
To do these experiments safely, you will need two partners. These experiments will let you compare how well you do on two different tests before and after "drunkenness": walking a straight line, and connecting the dots. Use the chart to keep track of your results.

WALKING A STRAIGHT LINE

With masking tape or chalk, make a straight line about 3 m (10 feet) long on the floor. Walk from one end to another by putting one foot exactly in front of the other and have your partner time how long it takes you. Be sure to put the heel of one foot right against the toe of the other as you walk. If you accidentally put your foot down and miss the line, you must go back and start again.

CONNECTING THE DOTS

Use one of these groups of three lines each time you do the "connect the dots" test. The idea of this test is to see how well you can draw a wavy line through one "connect the dots" group in 10 seconds. Give yourself one point for each dot you cross and for each time you touch the top or bottom line without crossing over it.



Here is the way the connect-the-dot group would look if you did it perfectly:

GETTING "DRUNK"

Now that you have done the "before" tests, you are ready to get the effects that happen when a person is drunk. If you are under a doctor's care, have dizzy spells or heart problems, or are not able to participate in physical education, you should not be one of the team members who gets "drunk."

NAME	WALKING A STRAIGHT LINE	
	BEFORE	AFTER

NAME	CONNECTING THE DOTS	
	BEFORE	AFTER

The person who is to get "drunk" should spin around in place for 10 seconds. Be sure that the area is cleared of furniture in case the person falls. Also, the two partners should stand nearby to catch the spinning person in case she or he starts to fall.

As soon as the person has spun for 10 seconds, have him or her do one of the tests. Give each person a turn to get "drunk" by spinning before each test.

(1.) How did each team member do — before and after getting the effects?

(2.) Did girls do better than boys?

(3.) What effects do you think drunkenness would have on a person driving a car or operating machinery?

(4.) How do the police in your community check people to see if they are drunk?

POSTURE CHECKUP

Good posture helps you feel fit. Poor posture is really just a bad habit that is important to correct when you are young. By walking, standing, and sitting properly you'll find that you will not only look better but you'll also feel better.

The activities listed below will help you check on your posture. It might be fun to work on posture improvement with a friend. By being partners you'll be able to remind each other to keep your posture in good shape.

Here is a chart that you can use to record the results of your posture checkup.

DATE	NAME		
	EXCELLENT	GOOD	POOR
STANDING			
SITTING			
LIFTING			

Standing
Just stand the way you normally stand. Pretend that you are in a lunch line or a line to see the movies. Have your friend check your posture.

Here is what to check for: Are your ears, shoulders, hips, and ankles in line when seen from the side?

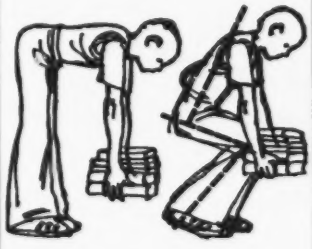
Here is how to improve: Stand with your back to the wall and slowly press your body to the wall so that the four body parts are in line.

Sitting
Sit on a chair or at a chair-desk combination the way you usually do. Have your partner check to see whether your ears, shoulders, hips, knees, and ankles could be connected by imaginary straight lines that look almost like those in the drawing.

Here is how to improve: Press back into your chair so that the back of the chair comfortably supports your back. Bring your knees up so that the weight of your legs is pressing straight down upon your feet. Now, just relax your body a little so that you feel comfortable.

Lifting
Put a pile of books on the floor. While your partner is watching, bend down and pick up the books.

Here is what to check for: Would imaginary lines running through your ears, shoulders, hips, knees, and feet look somewhat like this?



Here's how to improve: Remember to keep your back straight when you bend down and come up with the books in your hands. Keep the books close to your body and use the strength of your legs to put yourself upright.

ELIZABETH BLACKWELL, WOMAN DOCTOR

Elizabeth Blackwell (1821–1910) was laughed at. She wanted to be a doctor, but in the 1840s women were not allowed to be doctors. She knew that she could be a good doctor if she could get into medical school. In 1847 she was admitted to the Geneva Medical School, in New York, but they had admitted her as a joke! The people who taught at the Geneva Medical School thought it would be funny to have a woman student, whom they would laugh out of school very quickly. After all, they could certainly show her that medicine was a career only for men.

When Elizabeth Blackwell arrived at school, she quickly learned what she was up against. The teachers and the students made fun of everything she tried. If an experiment failed, it was because she was a female. For four years she lived with the laughter. In spite of all the problems, she did graduate from medical school in 1849 and was first in her class.

Dr. Blackwell opened her own clinic because so many doctors and patients opposed her. Her poor people's clinic allowed her to practice medicine and to help people who really needed it.

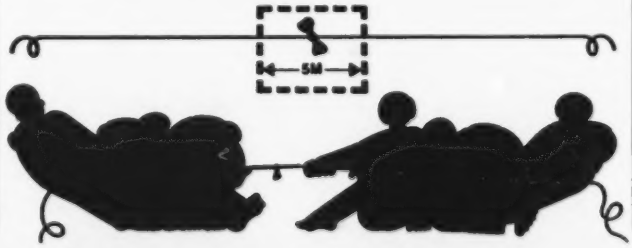
Later in life she started a medical school to educate women. She believed that doctors could be men or women and did everything that she could to help women who wished to become doctors.

1. Why do you think people didn't like the idea of having a woman become a doctor?
2. Are there any women doctors in your community?
3. If there is a woman doctor in your community, see if you can interview her. Try to find out if she had the problems Elizabeth Blackwell did.

We thank Eileen Hammond of the South Burlington, Vermont, Central School for her help with the biography of Elizabeth Blackwell.

TUG O' WAR

This is a great game to use to put magnificent you to work. Obtain a thick rope at least 25 m long. Set up a "tug o' war" area. A sandy area is best, such as a beach or a huge sandbox. The neutral zone between the two teams should be at least 5 m wide, as shown in the illustration. Tie a ribbon on the middle of the rope, and center the rope in the middle of the neutral zone. The team that pulls the ribbon into its zone wins the game. The game should be at least the best two out of three to establish a winner. Talk about tired muscles!



WHY DO SOME PEOPLE SMOKE?

You have probably seen television announcements that try to convince people not to smoke. The American Heart Association, the American Cancer Society, United States Government agencies, and many other groups spend a lot of money each year trying to get people to stop smoking, but many smokers ignore these warnings.

It is hard for people to "kick the habit." To help you understand why some people smoke, you will need to get some information from people who have the smoking habit. Here is a chart you can use to interview smokers.

You may wish to have smokers fill out the chart by circling their answers. Another way to use the questionnaire is for you to read statements A through R aloud and have the smoker answer by saying "always," "frequently," "occasionally," "seldom," or "never." If you read the statements, be sure to circle the smoker's answer.

When you are done, figure out the person's score by using the method shown under "How To Score."

SMOKING QUESTIONNAIRE

Here are some statements made by people to describe what they get out of smoking cigarettes. How often do you feel this way when smoking them? Circle one number for each statement. IMPORTANT: Answer every question.

		ALWAYS	FREQUENTLY	OCCASIONALLY	SELDOM	NEVER
A.	I smoke cigarettes in order to keep myself from slowing down.	5	4	3	2	1
B.	Handling a cigarette is part of the enjoyment of smoking it.	5	4	3	2	1
C.	Smoking cigarettes is pleasant and relaxing.	5	4	3	2	1
D.	I light up a cigarette when I feel angry about something.	5	4	3	2	1
E.	When I have run out of cigarettes, I find it almost unbearable until I can get them.	5	4	3	2	1
F.	I smoke cigarettes automatically, without even being aware of it.	5	4	3	2	1
G.	I smoke cigarettes to stimulate me, to perk myself up.	5	4	3	2	1
H.	Part of the enjoyment of smoking a cigarette comes from the steps I take to light up.	5	4	3	2	1
I.	I find cigarettes pleasurable.	5	4	3	2	1
J.	When I feel uncomfortable or upset about something, I light up a cigarette.	5	4	3	2	1
K.	I am very much aware of the fact when I am not smoking a cigarette.	5	4	3	2	1
L.	I light up a cigarette without realizing I still have one burning in the ashtray.	5	4	3	2	1
M.	I smoke cigarettes to give me a "lift."	5	4	3	2	1
N.	When I smoke a cigarette, part of the enjoyment is watching the smoke as I exhale it.	5	4	3	2	1
O.	I want a cigarette most when I am comfortable and relaxed.	5	4	3	2	1
P.	When I feel "blue" or want to take my mind off cares and worries, I smoke cigarettes.	5	4	3	2	1
Q.	I get a real gnawing hunger for a cigarette when I haven't smoked for a while.	5	4	3	2	1
R.	I've found a cigarette in my mouth and didn't remember putting it there.	5	4	3	2	1

This questionnaire is part of the *Smoker's Self-Testing Kit* developed by Daniel Horn, Director of the National Clearinghouse for Smoking and Health of the Public Health Service. You can get the complete pamphlet by ordering DHEW Publication #(CDC) 75-8716 from the U.S. Government Printing Office, Washington, D.C. 20402. It costs 40 cents.

HOW TO SCORE

Enter the numbers you have circled in the spaces below, putting the number you have circled to statement A over line A, to statement B over line B, and so on.

Add together the three scores on each line to get your totals. For example, the sum of the scores over lines A, G, and M gives you the score on Stimulation; lines B, H, and N give the score on Handling; and so on.

				Totals
____ A	+ ____ G	+ ____ M	=	____ Stimulation
____ B	+ ____ H	+ ____ N	=	____ Handling
____ C	+ ____ I	+ ____ O	=	____ Pleasurable Relaxation
____ D	+ ____ J	+ ____ P	=	____ Crutch: Tension Reduction
____ E	+ ____ K	+ ____ Q	=	____ Craving: Psychological Addiction
____ F	+ ____ L	+ ____ R	=	____ Habit

Scores can vary from 3 to 15. Any score 11 and above is high; any score 7 and below is low.

What Do the Scores Mean?

There seem to be six basic reasons why people smoke:

1. Stimulation: *They feel they have more energy afterward.*
2. Handling: *They like the feeling of holding and handling an object.*
3. Pleasurable relaxation: *They feel better or more relaxed.*
4. Crutch: *They feel less nervous in situations that bother them.*
5. Psychological addiction: *They are mentally addicted to smoking.*
6. Habit: *They smoke it without realizing that they are smoking.*

Any score of 11 or more on any one of the six reasons means that this is the smoker's most important reason. If the person does not have a score of above 11 on any one reason, he or she should have a fairly easy time of "kicking the habit."

By doing this interview you've had a chance to learn about the reasons that people give for smoking. None of the reasons is important enough to balance the serious danger that smokers are putting themselves (and perhaps others) in.

If someone you know is trying to kick the habit, remember to encourage him or her in a positive way. Preaching will probably not do much good. Just let the person know that you care and that you want him or her to have a long, healthy life.

BREATHING RATE

FIND OUT HOW MANY BREATHS YOU TAKE IN ONE MINUTE WHEN YOU ARE SITTING QUIETLY. DO THIS THREE TIMES AND FIND YOUR AVERAGE BREATHING RATE PER MINUTE (ADD THE THREE TOGETHER AND DIVIDE BY THREE).

NOW DO SOME EXERCISES AND CHECK YOUR BREATHING RATE AGAIN. WAS THERE A CHANGE IN YOUR BREATHING RATE?

HAVE OTHERS TRY THE EXPERIMENT. HOW DID THEIR BREATHING RATES COMPARE WITH YOURS?

TAKING A BREATHER

Our breathing system allows us to take in air, remove oxygen from it, and exhale a body waste product called carbon dioxide (CO_2). In this activity you'll be able to study how much air your lungs can hold. This is a good activity to do with a partner.

Materials

gallon glass bottle or jug (you can use a plastic container if it is transparent enough to see the level of water that you put in it)
½ m section (about 20 inches) of plastic or rubber tubing (you can get this in a hardware store or hobby shop)
marking pen
sink and large cake pan

Directions

1. Thoroughly wash out the jug with soap and water.
2. Fill the jug completely with water.
3. Put the cake pan in the bottom of the sink and fill it with water.

4. Have your partner cover the mouth of the jug with his or her hand and then turn it upside down.
5. Carefully put the upside-down jug in the pan. Be sure your partner holds the jug and keeps it from falling.
6. Slip one end of the tubing under the mouth of the bottle and into the water. Hold the other end of the tubing in your hand.

7. Now take a deep breath and exhale the air through the tube and into the water. Squeeze the end of the tube shut.
8. Mark the new level of the water on the side of the jug.
9. Refill the jug with water, wash out the end of the tubing where you put your mouth, and have your partner try the experiment and mark his or her water level.

To find out your lung capacity, empty the jug and see how many liters or quarts of water it takes to fill the jug to the place that you marked.

Here is a chart you can use to keep track of your lung capacity:

NAME	LUNG CAPACITY

YOUR TASTER

Our ability to taste things helps us to enjoy eating. There seem to be four kinds of tastes: sweet, sour, salty, and bitter.

In this activity you'll be able to see how well a group of people agree on the kind of taste something has. Each person will taste something while blindfolded and will then say which of the four tastes it has. Some foods have a combination of tastes, so the person doing the tasting may mention more than one taste. ONLY DO THIS EXPERIMENT WITH FOODS. NEVER TASTE OTHER MATERIALS, AS THEY MAY BE HARMFUL.

Materials

box of toothpicks
eight small paper cups or baby food jars
small samples of at least eight foods (such as ketchup, mustard, syrup, instant coffee, vinegar, salt, soft drinks, lemon juice, chocolate syrup, peanut butter)
material for a blindfold

Directions

1. Use a chart (like the one we've provided) to record how the person describes the taste.
2. Blindfold the taste tester.
3. Using a fresh toothpick for each person, gently put a small amount of the food on the taster's tongue. Put it on the same area for each tongue.
4. Have the person describe the taste.
5. On the chart, write down what he or she says.
6. Now repeat the taste tests, but this time have the taster hold his or her nose closed during the test. Change the order in which you have the taster try the foods.
7. Are there differences when the taster can't smell the foods?

NAME _____

FOOD	TASTE — NOSTRILS OPEN	TASTE — NOSTRILS CLOSED
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

YOUR NOSE KNOWS

In these activities you'll have a chance to check on how sharp your sense of smell is. You'll need a partner for the experiments.

Different Smells

Collect some small samples of foods that have strong odors. Here are some suggestions:

salami	**cheese**
bologna	**coffee**
peanut butter	**tea**
onion	**orange**
garlic	**lemon**
pepper	**apple**
tomato	

Gather some empty baby food jars or small drinking glasses and place a food sample in each. Blindfold your partner and have her try to guess the food just by using her sense of smell.

Now switch places with your partner and have her check on your sense of smell.

Smelling Time

Get a small bottle of aftershave lotion or perfume and a saucer. You will also need a watch or a clock with a second hand.

Blindfold your partner and have him or her stand about 2 m (about 7 feet) away from the saucer.

Now put a little of the perfume or lotion into the saucer and put the cap back on the bottle. How many seconds does it take for the smell of the perfume to reach your partner?

In order to repeat this experiment so you get a chance to try it, you will have to rinse the saucer out with water and thoroughly air out the room or go to another room.

Who smelled the perfume or lotion first? Try the experiment with different perfumes or lotions.

Extra Added Attraction: While your partner is blindfolded, ask him to taste an apple slice (without knowing what it is) while you hold a cut onion by his nose. How does he describe the taste?

SIDE VISION

Have you ever had teachers who seemed to have "eyes in the back of their heads"? Well, your teachers didn't really have eyes back there, but they probably had good vision at each side of their eyes. In other words, when they were looking straight ahead, any nonsense that you were doing (throwing spit balls, making faces) at the side of the room was seen by their sharp eyes.

Here is a way to check on how good your side vision is. This is a good experiment to do with a partner.

1. ***Sit facing straight ahead.***
2. ***Keep your eyes focused ahead of you and have your partner bring a pencil slowly around your head, starting about a meter (40 inches) away straight out from your ear.***
3. ***Tell your partner when you first see the pencil.***
4. ***Try this on both sides.***
5. ***Now let your partner try it.***
6. ***Who has better side vision, you or your partner?***

What problems would a person with poor side vision have if she were an athlete? An automobile driver? A police woman?

The Fat Game

Would you like to try your luck at the Fat Game? Turn to the "Games and Other Nifties" section.

SNACK SURVEY

1. NAME	2. SNACK	3. SERVINGS	4. CALORIES PER SERVING	5. CALORIES EACH DAY

Some people eat lots of snacks during the day. In this activity you'll be able to help people discover the number of calories they take in when they eat snacks.

Ask your friends and relatives about their favorite snacks. Use this chart to keep track of their answers.

Write down their names in column 1. Write down the names of their favorite snacks in column 2. Ask them how many servings they eat each day and put the answer in column 3.

Look at Table 2 and record the number of calories in one serving in column 4 in the above chart. Multiply the number in column 4 by the number of servings the person eats in one day. Put that amount in column 5.

1. **What seems to be the favorite snack on your list?**
2. **What snacks are the highest in calories?**
3. **What snacks are the lowest in calories?**
4. ***Are the people who eat higher-calorie snacks "plumper" than the people who eat lower-calorie snacks?***

Table 2 SNACK AND DESSERT LIST

Food	*Approximate Calories*
Milk shake (fountain size)	*400*
Malted milk shake (fountain size)	*500*
Sundae	*215-325*
Soda	*260*
Hamburger (including bun)	*360*
Hot dog (including bun)	*210*
Pizza (4"-5" section)	*135*
Popcorn, lightly buttered (⅓ cup)	*75*
Nuts (3 tbsp. chopped, or 30 peanuts)	*150*
Poundcake (¾" slice)	*140*
Cupcake with frosting (2¾" diameter)	*185*
Layer cake with frosting (2" slice)	*370-445*
Brownies (2" x 2" x ¾")	*140*
Plain cookie (3" diameter)	*120*
Pie (⅛ of a 9" pie)	*275-345*
Fruit juice (1 cup)	*110-165*

Note: One slice of bread has approximately 70 calories. When these foods are used in place of bread they will not have the same nutritive value.

The snack and dessert list is from *Nutrition for Athletes*, copyright 1971 by the American Alliance for Health, Physical Education, and Recreation, Washington, D.C. Used with permission.

USING UP CALORIES

This is a good activity to do if you want to know how many calories you use up by engaging in various kinds of exercises or sport activities. Interview friends or relatives and ask them about the kinds of exercise they get. Use the chart to record their answers to these questions:

What kind of exercise do they get?

About how many minutes do they spend exercising each week?

Put the answers in column 2 and column 3.

Look at the list of sports and exercises in Table 3 and record the number of calories per minute in column 4.

By multiplying column 3 by column 4 and putting the answer in column 5, you'll be able to show people how many calories they use in a week.

1. What kinds of exercise use up the most calories?
2. What kinds of exercise do most people do?

EXERCISE SURVEY

1. NAME	2. KIND OF EXERCISE	3. MINUTES PER WEEK	4. CALORIES PER MINUTE	5. TOTAL CALORIES USED EACH WEEK

Table 3 ENERGY COST OF EXERCISE

Sport or Exercise	*Total Calories Expended per Minute of Activity*
Climbing	*10.7–13.2*
Cycling	
5.5 mph	*4.5*
9.4 mph	*7.0*
13.1 mph	*11.1*
Dancing	*3.3–7.7*
Football	*8.9*
Golf	*5.0*
Gymnastics	
Balancing	*2.5*
Abdominal exercises	*3.0*
Trunk bending	*3.5*
Arm swinging	*6.5*
Rowing	
51 strokes per minute	*4.1*
87 strokes per minute	*7.0*
97 strokes per minute	*11.2*
Running	
Short-distance	*13.3–16.6*
Cross-country	*10.6*
Tennis	*7.1*
Skating (fast)	*11.5*
Skiing	
Moderate speed	*10.8–15.9*
Uphill, maximum speed	*18.6*
Squash	*10.2*
Swimming	
Breaststroke	*11.0*
Backstroke	*11.5*
Crawl (55 yards per minute)	*14.0*
Wrestling	*4.2*

The energy cost of exercise chart is from *Nutrition for Athletes*, copyright 1971 by the American Alliance for Health, Physical Education, and Recreation, Washington, D.C. Used with permission.

REACTION TIME

Imagine that you are running along a beautiful beach in your bare feet. It is a hot, sunny day and your eyes are on a man selling ice-cold soda. You want to get to him before he runs out of soda and you are really moving quickly. You happen to glance down and see that your right foot is heading for a piece of broken glass. Do you think you could keep yourself from getting cut?

The amount of time it takes for your right foot to react to the view of the broken glass is called your *reaction time*. Different people have different reaction times, and most of us can speed up our reaction time with practice.

These activities will give you a chance to see how quickly you can react. It would be fun to do them with a friend so that you can compare reaction times.

Penny Grab

Hold your right arm out, and, keeping the back of your hand up, put a penny on the center of the back of your hand.

Now slowly tilt your hand to the side so that the penny slides off. Try to catch the penny.

Do this five times and keep track of how many catches you make.

Do it another five times. Did you get any better with practice?

Try it with your left hand. How does the reaction time of your left hand compare with that of your right hand?

Penny Drop

Hold your hand out with the palm facing up. Have a partner hold a penny about ½ m (about 20 inches) above the palm of your hand. When your partner drops the penny, try to move your hand out of the way before the penny hits it.

Do this at different distances.

Switch positions with your partner.

Find out if boys or girls have a quicker reaction time for the penny drop.

One-Hand Slapper

You need a partner for this hand-slapping activity. This is a great deal of fun but don't get carried away and hurt your partner. Be sure to take off any rings or bracelets that you or your partner may be wearing.

Hold your hand out with the palm up. Have your partners rest his or her palm on yours. If you are holding out your *right* hand, your partner should rest his or her *left* hand on yours.

The idea is for you to turn your hand over fast enough to slap the back of your partner's hand before it is removed. This activity is testing your hand-turning speed against your partner's reaction time.

Switch positions with your partner.

Two-Hand Slapper

Try the one-hand slapper with two hands. Try to turn both of your hands over before your partner can remove his or her hands.

Which hand has the best reaction time when your hands are above your partner's?

Catch a Falling Stick

Hold your hand out with your thumb and forefinger separated. Have your partner hold a meterstick or yardstick at one end so that the other end of the stick is between your thumb and forefinger.

Keep your eyes on the bottom end of the stick and ask your partner to release the top end at any time. Try to catch the measuring stick between your thumb and forefinger. The distance that the stick falls before you catch it gives you an idea of your reaction time.

Switch positions with your partner.

FINDING YOUR BLIND SPOT

The inside back surface of your eye is called the *retina*. Light rays bouncing off objects that you look at enter the front of your eye and reach light-sensitive cells on the retina. Few people realize that there is a part of the retina that does not have these light-sensitive cells.

This area of the retina causes a "blind spot" in your vision. It is the place where the optic nerve is connected to the retina.

Here is how to find the blind spot in your vision. Look at the drawings and follow these directions:

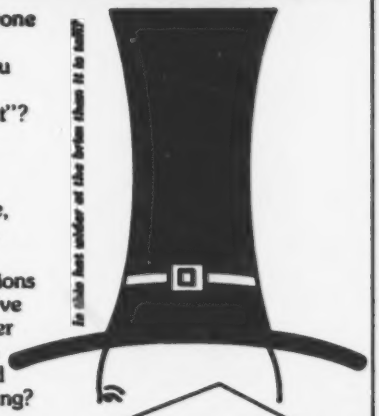
1. Hold the page so that the boy is toward your left eye.
2. Close your left eye.
3. Hold the page about 45 cm (about 18 inches) in front of you.
4. Keep your right eye focused on the boy.
5. Now slowly move the drawing closer to you and then away from you.
6. If the drawing of the girl disappeared at some point while your right eye was focused on the boy, you found the blind spot.
7. Now try the experiment with your left eye.

Why isn't there a hole in our vision when we look around? (Hint: Is the right eye's blind spot in the same place as the left eye's?)

OPTICKLERS

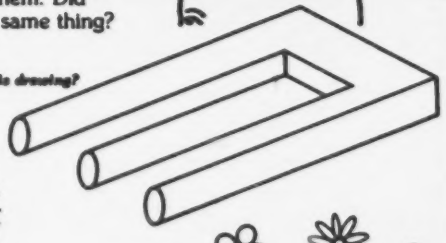
Have you every heard anyone say:
"What you see is what you get"?
"I'll believe it when I see it"?
"One picture is worth a thousand words"?

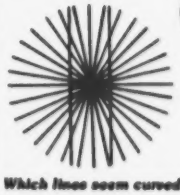
Well, you'd better not believe everything you see, because your eyes can be fooled. Here are some "opticklers" — optical illusions — to check on. After you've answered the question after each optickler, have some other people try them. Did everyone see the same thing?



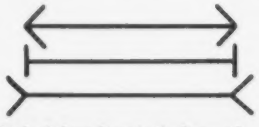
Is this hat wider at the brim than it is tall?

Are you confused by this drawing? What do you see?





Which lines seem curved?



Which of these lines is the longest?

Which of these vases is wider at the bottom?

EAR TO THE TABLE

Have you ever seen a cowboy movie in which the scout is trying to figure out how close a buffalo herd is? Usually, he kneels down and puts an ear to the ground. The sounds of the buffalo trampling on the earth travel through the ground and reach the scout's ear.

In this activity you'll find out how good a buffalo scout you would have been. You will need a partner for this.

Materials

ticking watch or nonelectric clock
long, clean table
meterstick or yardstick

Directions

1. Put one ear to the table top.
2. Have your partner put the watch or clock at one end of the table.
3. Keep your eyes closed.
4. Ask your partner to begin moving the watch or clock toward you.
5. When you first hear it, raise your hand.
6. Measure the distance from your ear to the furthest distance at which you could hear the clock.
7. Try the experiment with each ear.
8. Now let your partner do the experiment.

CHARLES RICHARD DREW, PHYSICIAN

Charles Drew (1905–1950) was a brilliant physician. While a young doctor in the 1930s, he foresaw that as surgery became more complex, more and more blood transfusions would be required. At that time the common method of transfusion was directly from one person to another. This method could be used only when the two persons had matching types of blood. Dr. Drew realized that a way must be found to store blood so that it would be available when needed.

The young man knew it would take many long hours of work to find a solution to this problem. However, he was used to working hard. As a black in the 1920s, it had been difficult for him to be accepted at a top-ranking college. He was finally admitted to Amherst College, in Massachusetts. Charles Drew was both an outstanding scholar and an exceptional athlete, winning many awards in track and football. At McGill University Medical School, in Montreal, he was captain of the track team and graduated with honors in 1933.

For the next seven years Dr. Drew worked on the problems of storing blood. He discovered that with proper refrigeration and the addition of certain chemicals blood could be stored for many weeks without harm. Even more

important was his discovery that the fluid part of blood could be separated from the red blood cells. This fluid — blood plasma — could then be used for transfusions without the necessity of matching blood types.

At the beginning of World War II Dr. Drew spent a year instructing the British in his techniques of blood collection and storage. He also helped create the first blood bank in England. On his return to America he supervised the collection of blood for the United States Army.

Blood transfusions now save the lives of thousands daily. Without Dr. Drew's discovery today's great surgical advances would not have been possible.

1. Do you know many people who are as good at doing as many things as Dr. Drew was?

2. Do you think Dr. Drew was a person who stuck with a problem even when there didn't seem to be an answer? Are you like Dr. Drew when it comes to trying to solve problems?

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MAGNIFICENT BOOKS!

The Food You Eat by John S. Marr. New York: Evans, 1973, $3.95.

Germs Make Me Sick: A Health Handbook for Kids by Parnell Donahue and Helen Capellar. New York: Knopf, $2.95.

How Did We Find Out About Vitamins? by Isaac Asimov. New York: Walker, 1974, $4.95.

Human Engineering: The Body Reexamined by John Lenihan. New York: Braziller, $7.95.

The Skin by Alvin and Virginia Silverstein. Englewood Cliffs, N.J.: Prentice-Hall, 1972, $4.95.

Why You Feel Hot, Why You Feel Cold: Your Body's Temperature by James Berry. Boston: Little, Brown, 1973, $4.50.

Your Living Bones: An All About You Book by Louis McNamara and Ada Litchfield. Boston; Little, Brown, 1973, $4.50.

CHAPTER 6

DON'T TAKE EVERYTHING FOR GRANITE

It's early in the morning; all is still and quiet. Suddenly the lights begin to flicker, a thundering sound begins to lift the floor, the walls begin to crack. You know it's an earthquake. Rocks, normally able to withstand tons of pressure, split apart like glass from the enormous power of the earthquake force.

The crust of the earth is our home. We live on this sea of rocks and soil, but we seldom realize that our food, the materials we use to build our homes, our medicines, our precious stones, our cars and airplanes, and much more come from the crust of the earth. Explore this marvelous place — look at rocks and minerals with more appreciation, sift your hand through the soil, and be awed by the majestic volcanoes, mountains, and canyons. But don't take it for granite!

DON'T KICK THE ROCK

by Patty Zeitlin and Ruth Buell

"Don't Kick the Rock" © 1976 by Patty Zeitlin and Ruth Buell. All rights reserved. Used with permission.

When it's early in the day, and you're skipping on your way
You may hear a little noise come from the ground,
In a voice so meek and treble, crying, "Don't pick on the pebble,"
"Cause pebbles can get bruised, if kicked around."
Chorus: Don't pick on the pebble, on the pebble.
It isn't a nice thing to do.
Don't pick on the pebble, on the pebble.
You'll never see a pebble pick on you.
When you're bouncing on the beach, all of nature's in your reach,
And you may commit a crime upon the shore.
Please oh please don't squish the sand or hold it tightly in your hand.
If you've done it, please don't do it anymore!
Chorus: Don't squish the sand, squish the sand.
It isn't a nice thing to do.
Don't squish the sand, squish the sand.
You'll never see sand squish you.
Now, let's review what we have learned.
If to nature you've returned,
Do not hurt a pebble, grain of sand, or stone.
If you really, really care, you will walk on just the air.
Chorus: Don't kick the rock, kick the rock.
It isn't a nice thing to do.
Don't kick the rock, kick the rock.
You'll never catch a rock kicking you.
(Spoken at very end) DON'T TOUCH ANYTHING!

ROCK TEST CHART

You can use a chart like this to record observations and results of tests that you carry out while investigating rocks and minerals. Making careful observation of rocks and minerals is an important way to understand the nature of the earth's crust. It is not necessary to do all the tests and make all the observations suggested. You may want to begin your study with just a few of the simple tests and then later do more detailed studies. Use this as a model. Make up your own charts like the one shown here.

Rock or Mineral	Color	Shape of Crystals	Streak Test	Vinegar Test	Magnet Test	Electrical Test	Weight	Density Test

ROCK AND MINERAL TESTS

You can use any collection of rocks and minerals to do these tests. Record the results of the tests on the rock test chart (page 47). To do these tests you will need to gather the following materials:

STREAK PLATE
PORCELAIN STREAK PLATE (A BROKEN PIECE OF PORCELAIN DISH WILL DO)
VERY DILUTE HYDROCHLORIC ACID (HCl) OR A BOTTLE OF VINEGAR
MAGNET
ROCK
HAND LENS
BATTERY, BULB, WIRE

Color

Color is often the obvious characteristic of a rock or mineral. However, you will find considerable variation in how people describe colors. Using a painter's color chart might help. Another problem arises that you should be aware of when describing the color of a rock: Some rocks and minerals are only one color, while others are composed of several materials, each with different colors. Make a note of this when recording your observations.

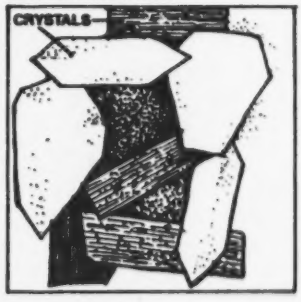
Shape and Arrangement of Crystals

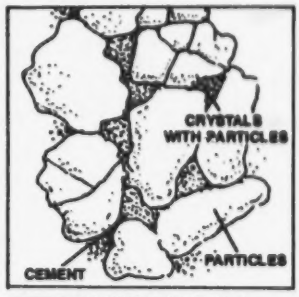
Rocks are composed of one or more minerals. Paying attention to how the minerals are held together and how they are arranged in the rock is important. Follow this sequence when studying rock crystals:

1. Look at the rock to determine if the crystals are "melted" together (interlocking) or glued together (noninterlocking).
2. Check to see if the crystals in the rock are in a "lined up" or "not lined up" position.

Adapted from *Rocks and Charts*, Educational Services, Incorporated, Webster Division, McGraw-Hill Book Co., New York, 1969. No endorsement given. Used with permission.

INTERLOCKING, OR "MELTED TOGETHER," IGNEOUS AND METAMORPHIC ROCKS





NONINTERLOCKING, OR "GLUED TOGETHER," SEDIMENTARY ROCKS

Streak Test or Rock Writing

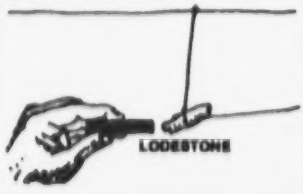
When you rub a rock across a material like porcelain, a powder is left in the form of a streak. The color of the powder is sometimes helpful in identifying the rock. Test each rock by carefully rubbing across a porcelain plate . . . called a streak plate.

Now for the rock writing. Have available a variety of rocks — especially anthracite (coal), talc, and gypsum — and different colors of paper. Can you write and draw with the rocks?

Vinegar Test

Vinegar is a weak acid, and that's all you need to give your rocks the "acid test." Obtain rocks like quartz, limestone, kaolinite (clay), calcite, white marble, and writing chalk. Place a very small sample of each of these materials in separate small cups. Cover each sample with vinegar and observe what happens to each sample. Observe the cups 24 hours later.

Some of these materials (the ones composed of calcium carbonate) will fizz when acid is applied. The acid enables you to determine if calcium carbonate is present in the rock. Limestone, marble, calcite, and chalk are made of calcium carbonate. These rocks formed in water environments where calcium carbonate was formed. Which of the rocks you tested fizzed?



Magnet Test

Some rocks are attracted by magnets. This would indicate the presence of a metal, usually iron. Try rocks such as galena, hematite, magnetite, and shale.

If you can find a sample of lodestone, try the following experiment. Suspend a piece of lodestone, using a piece of light string. Place one end of a bar magnet close to one end of the lodestone. Observe what happens.

Lodestone is a natural magnet. If you bring the north (N) pole of a magnet close to the N pole of the lodestone, the rock should be repelled. If you reverse the pole on the magnet the rock and magnet should attract each other. Suspending the lodestone also makes the rock a natural compass. Can you find north?

Electrical Test

Some rocks conduct electricity. Use a battery, bulb, and wire to find out which ones do.

ROCKY GAMES

Here are two rocky games you might enjoy playing:

What Rock Am I Thinking About?

Arrange people in a circle. Each person should have a box of rocks and a completed rock test chart. The person who starts selects a rock that the others will try to identify. The person selecting the rock gives one observation or test result at a time. If anyone can guess with one observation, that person holds the rock up for identification. If this guess is correct, a new person selects a rock; if it is wrong, a new observation is given. This procedure is continued until the rock is identified.

Magic Show

Arrange people in a circle. One person should be identified as the magician. Before the game, have this person select about five rocks that he or she will perform magic with. Some examples are pumice (which will float), anthracite (which can be used to write on paper or on a balloon), asbestos (which has fibers that will not burn), calcite (which will fizz in acid), and willemite (or any rock tht will show fluorescence). As you can see, the idea is to select rocks that have unusual properties.

The game is carried out by having the magician perform tricks while the audience writes what they observe on a sheet of paper.

ROCK IDENTIFICATION KEY

This rock key will help you decide whether a rock is igneous, metamorphic, or sedimentary. All you need to identify most rocks is to be a good observer. To use the chart start with item 1a. Identify one rock at a time.

1a. If the rock is made up of minerals that you can see, go to 2a.

1b. If the rock is not made up of visible minerals, go to 5a.

2a. If the rock is made up of minerals that are interlocking ("melting together"), go to 3a.

2b. If the rock is made up of minerals that are noninterlocking ("glued together"), go to 6a.

3a. If the minerals in the sample are of the same kind, the rock is metamorphic.

3b. If the minerals in the sample are of two or more different types, go to 4a.

4a. If the minerals in the sample are distributed in a random pattern (not lined up), as shown in A, the rock is igneous.

4b. If the minerals in the sample are not distributed randomly but show a preferred arrangement or banding (lined up), as shown in B, the rock is metamorphic.

5a. If the rock is either glassy or frothy (has small holes), it is igneous.

5b. If the rock is made up of strong, flat sheets that look as though they will split off into slatelike pieces, it is metamorphic.

6a. If the rock is made of silt, sand, or pebbles cemented together (it may have fossils), it is sedimentary.

6b. If the rock is not made of silt, sand, or pebbles but contains a substance that fizzles when dilute hydrochloric acid is poured on it, it is sedimentary.

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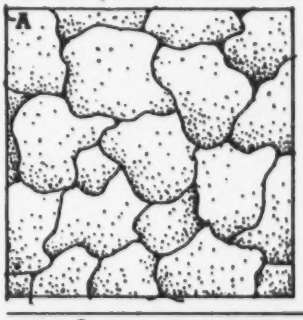


Find Your Rock

Arrange everyone in a circle. Place a collection of rocks in the center of the circle. Have each person select a rock and give everyone a few minutes to observe the rock carefully. Each person should now pass his or her rock to the right. Continue passing rocks to the right. After three or four passes tell the group that the object is for each person to get his or her own rock back without looking at the rocks as they are passed. To make it more interesting, have everyone in the circle change positions before passing any more rocks on. Continue passing the rocks slowly, and as people identify their rocks, they should remove themselves from the circle. The game ends when everyone has identified his or her rock.

MINERAL IDENTIFICATION CHART

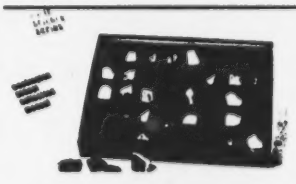
1. Luster	2. Hardness	3. Cleavage	4. Special Properties	Name
nonmetallic	harder than glass	cleavage	White and pink, good cleavage	Feldspar
		no cleavage	red, brown, or yellow	Garnet
			green, glassy grains	Olivine
			transparent, milky-white	Quartz
	softer than glass	cleavage	white-muscovite; black-biotite; cleaves as thin sheets	Mica
			white mark on streak plate; can scratch with fingernail	Gypsum
			perfect cubes, salty	Halite
			effervescee in acid, colorless and white	Calcite
			dark-green to black; two cleavage surfaces	Hornblende
		no cleavage	green or blue color, concoidal fracture	Azurite
			green or blue, pale green streak, concoidal fracture	Malachite
metallic	harder than glass	cleavage	brass color, cubic	Pyrite
		no cleavage	magnetic, black	Magnetite
			iron ore, black	Hematite
	softer than glass	cleavage	perfect cubes, heavy, gray	Galena
			black, can mark paper	Graphite
		no cleavage	fool's gold, copper color	Chalcopyrite

This chart is designed to help you identify common rock-forming minerals. Identification of minerals depends on your skills in observing samples. To use the chart make the following decisions in this order:

1. Determine the luster of the mineral — is it metallic or nonmetallic looking?
2. Determine the relative hardness of the mineral — will it scratch or not scratch glass?
3. Determine if the mineral shows cleavage — do any of the mineral's surfaces flash when you rotate it in good light?
4. Determine any special properties of the mineral.

ROCK AND MINERAL COLLECTIONS

Student Collection
63961 $3.55
Here is a carton of rocks and mineral specimens for you and your friends to identify. Available from Science Kit.



New Washington School Collection
63960 $21.60
If you are a rock hound, you may be interested in this rock collection. It's a collection of twenty rocks and twenty minerals. Available from Science Kit.

PLOTTING EARTHQUAKES

Earthquakes reveal the incredible forces that exist within the earth. In this activity, which will actually be an extended investigation, you will study the pattern of earthquakes. To do this you need to:

1. Obtain a map of the world, such as the one shown below.

2. Write to the Coast and Geoletic Survey, Environmental Science Services Administration, Rockville, Maryland 20852, and request that your school receive copies of the "Preliminary Determination of Epicenters" cards. We suggest you use school letterhead when requesting the Epicenter cards.

When the Epicenter cards arrive, you will get data on the occurrence of earthquakes, such as that shown here.

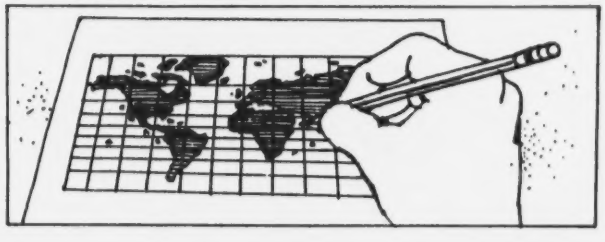
Day of Month	Origin Time			Location		Region	Depth (km)	Magnitude (Richter Scale)
	Hr.	Min.	Sec.	Lat.	Long.			
1	01	12	26.8	37.2N	30.2E	Turkey	35	4.8
1	02	47	51.6	7.0N	73.1W	Northern Colombia	140	4.3
1	03	51	45.4	5.1S	151.7E	New Britain Region	110	5.0
1	05	19	23.4	51.7N	172.9W	Felt (III) at Rabaul Andreanof Islands, Aleutian Is. Mag. 6 (Pas)	40	5.5
1	06	14	50.2	25.6S	176.8W	South of Fiji Islands	44	5.4
1	07	36	54.4	51.9N	172.9W	Andreanof Islands, Aleutian Islands	48	3.9
1	07	50	10.7	38.7N	14.1E	Sicily	N	4.3
1	11	56	29.8	5.4S	148.0E	East New Guinea Region	73	
1	12	26	55.6	44.6N	7.5E	Northern Italy Felt (III) in Côte d'Azur	18	4.4
1	12	48	32.8	56.2S	27.4W	South Sandwich Islands Region	17	5.1
1	14	21	42.9	42.3N	85.3E	Northern Sinkiang Province, China	N	4.8
1	14	43	26.6	2.9S	139.1E	Near N. Coast of West New Guinea	48	
1	14	56	23.1	6.2S	154.6E	Solomon Islands	103	5.4
1	14	59	12.6	62.3N	145.7W	Central Alaska	15	4.8

From "Crusty Problems" © 1972 Florida State University, published by Silver Burdett Co., Morristown, New Jersey, p. 5. Used with permission of the copyright holder. No endorsement given.

Each reported earthquake should be plotted on the world map. You can use symbols or colored pins to plot each quake on the map. The earthquake should be plotted according to depth:

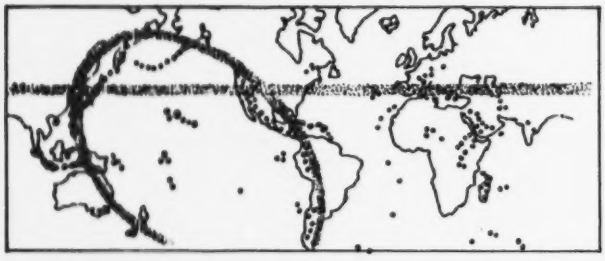
Earthquake	Depth in KM	Symbol
Shallow	0–69	* or red pin
Intermediate	70–299	+ or yellow pin
Deep	more than 299	o or blue pin

You should maintain your earthquake watch for several months. By that time a pattern of earthquakes will begin to take shape. As you continue your earthquake study, watch for newspaper articles about earthquakes.



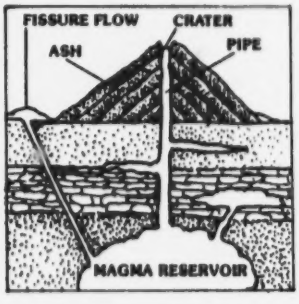
HOW TO MAKE A VOLCANO

Volcanoes are mountains that are formed by the piling up of molten material from beneath the earth's surface. Volcanoes occur all over the world, as shown on this map.



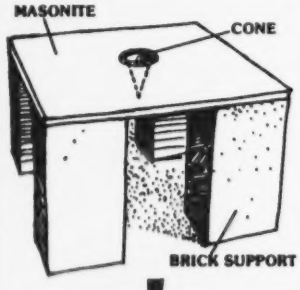
Notice that the west coast of North and South America is rimmed with volcanoes. Most of the islands in the Pacific (including Hawaii) were formed by volcanoes that erupted at the bottom of the ocean. Gradually enough material accumulated so that the volcano rose higher than sea level.

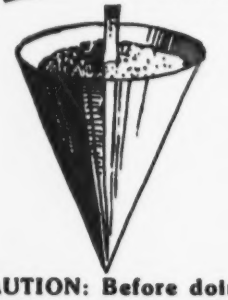
A typical volcano looks like the illustration shown here.



You can get an idea of how the volcanic cone forms and of how the molten material pours out of the vent of the erupting volcano by building your own.

You'll need a copper cone, a piece of masonite, four bricks, a small amount (2 teaspoonfuls) of ammonium dichromate powder, and one piece of magnesium ribbon. Set up the materials as shown here.





CAUTION: Before doing anything, put your safety glasses on! Make sure no other children are standing nearby.

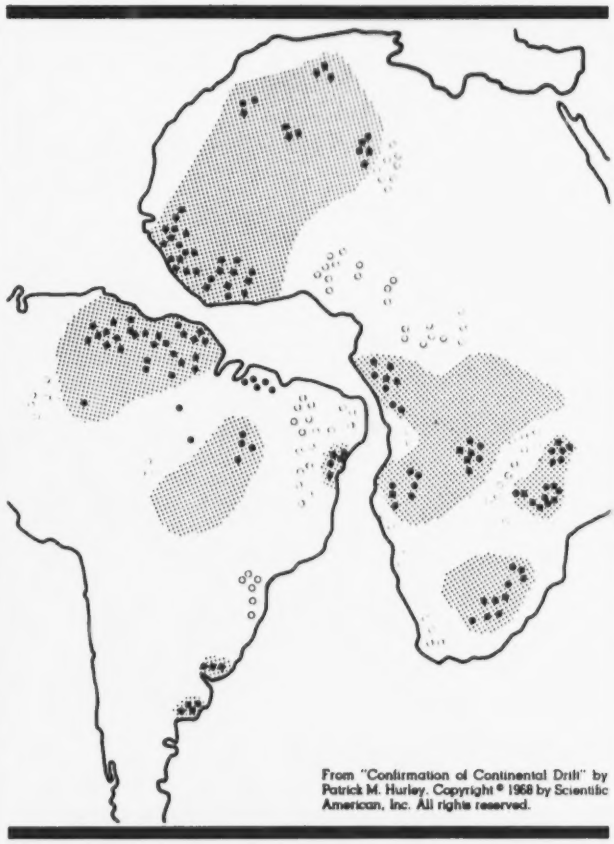
Pour the ammonium dichromate into the cone but do not pack it down. Insert the piece of magnesium ribbon in the powder. Ignite the magnesium ribbon very carefully with a match. Don't look directly at the magnesium ribbon as it burns.

GOODBYE SAN FRANCISCO

Matching of the Rocks

If the continents were once together, then the rocks on separate continents should match up. Look at the map below showing the continents of Africa and South America. Geologists have been able to determine the age of rocks by measuring the amount of radioactivity in rock samples. The dots on the map show the locations of rocks that have been dated using the radioactive technique. The map also shows the location of the rocks on each continent by age.

Trace the map and match up the continents on the basis of similar rock ages.



From "Confirmation of Continental Drift" by Patrick M. Hurley. Copyright © 1968 by Scientific American, Inc. All rights reserved.

KEY
SOLID DOTS: location of rocks dated older than 2 billion years
OPEN DOTS: location of rocks dated younger than 2 billion years
DARK AREA: ancient rocks
LIGHT AREA: younger rocks

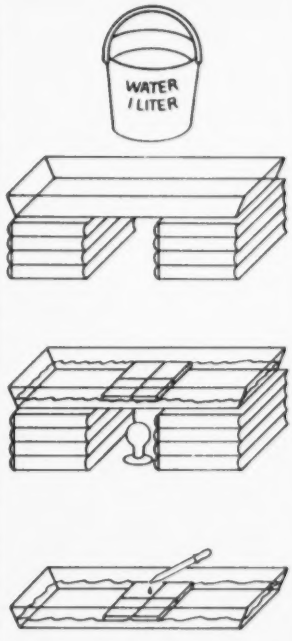
Geologists now believe that the continents we live on have moved about or drifted over millions and millions of years. San Francisco happens to be located near a place where huge pieces of crust are moving past each other. San Francisco is on one of those rafts that is moving toward the Pacific Ocean. This activity and "Continents A-Go-Go" will give you some information to help you understand this earth movement.

Shape of the Continents

Have you ever looked at a map and wondered about the shape of the continents? It almost looks like the continents are individual pieces of a gigantic puzzle. Just look at the outlines of South America and Africa. It looks like you could fit them snugly together if you could move them around.

Obtain a map or a globe and six pieces of tracing paper. Trace and cut out the following continents: North America, South America, Africa, Australia, Europe-Asia, and Greenland.

Try to fit all of the continents together such that there is no space existing between them.



The Big Split

You'll need the following materials: four wood blocks, 1 liter of water, a heat lamp or a 150 to 200 watt light bulb and socket, and a plastic shoe box.

Set the plastic box on two stacks of books. The box should be high enough so that the light bulb fits beneath. Pour the water into the box.

Place the four small wood blocks in the box. All the blocks should be touching, forming a large square. Place a light bulb beneath the plastic in the center of the four wood blocks.

Turn the light bulb on. Place a drop of food coloring in the water where the four wood blocks are touching. Observe the system for about 5 to 10 minutes.

What happened to each of the four wood blocks after the light was on for 5 minutes? What did you observe happening to the food coloring?

JAMES HALL, AMERICAN GEOLOGIST

James Hall's life spanned an age of great scientific progress and discovery in the United States. Hall was born in Hingham, Massachusetts in 1816. When he began his analysis of the geology of New York State in 1837 for the newly formed state geological survey, New York was still largely an unsettled frontier. Hall's report of his field trip quickly established his reputation.

In 1857, Hall advanced what was later called the geosynclinal theory of mountain building. It was based on his observations of a sedimentary rock sequence that decreased from a thickness of 12,000 meters in the Appalachian Mountains to one of only 1200 meters in the central plains near the Rockies.

From its texture and fossil content, Hall knew the rock must have formed from shallow-water sediments. This he explained with the theory that the sediments had been deposited in shallow slowly sinking ocean basins that had accumulated eroded materials so fast that they never became very deep. These basins, he felt, eventually contained the mass of material from which mountains formed. Hall did not attempt to explain the forces necessary to uplift these sediments into mountain ranges but only to account for the accumulation of such thick deposits. The concept of sinking ocean basins filled with sediments is considered an essential part of modern geology.

1. Find out how Hall's ideas of mountain building compare with current views of how mountains are formed.

2. What is a theory? How does a scientist develop theories?

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MAKING GEMSTONES

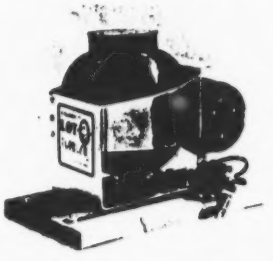
This project involves polishing minerals in a rock tumbler. Small pieces of the mineral are placed in the tumbler and are tumbled for about 30 days. The size of the grit is changed about every 10 days. To do this project you need the following:

(1.) Rock tumbler.

(2.) About 2 kg of a mineral. Selection of the mineral is based on its hardness. You can mix minerals in the tumbler **only** if they have the same hardness. A trip to a local rock shop will solve many of your problems.

(3.) If you wish to make jewelry with the polished rock, you will need cement, fasteners, chains, and clips.

You can obtain rock tumblers at any rock shop but here is one you can order:



66653 $43.20

If you're really into rock polishing, here is a rock tumbler that will hold up to 4 pounds of rocks. With its heavy-duty motor and tumbler barrel you'll be able to make gemstones that any rock shop owner would be proud of! Available from Science Kit.

Measuring Rock Sections

Another interesting field project is measuring a geological section. A section is a vertical exposure of rock strata. You can build an instrument called a Jacob's staff to measure the thickness of the beds. You will need:

board 1.5 m × 2.5 cm × 1.5 cm

board 30 cm × 2.5 cm × 1.5 cm

test tube corked and partially full of water

The staff can be used to measure the thickness of bedding planes. Start at the bottom of the outcrop and site along the top of the 30 cm board (the bubble in the test tube will help you maintain a horizontal level).

In your notebook record the thicknesses and sketch the beds to form a section. Collect rock samples and look for fossils in each bed.

Based upon "Measuring Rock Sections in Sedimentary Rocks" in Field Guide to the Soils by Henry Foth and Hyde S. Jacobs, Boston: Houghton Mifflin. Copyright © 1971 by the American Geological Institute.

MAKE YOUR OWN CONTINENTS A-GO-GO FLIP BOOK

Watch the continents do their dance, called the continental drift, or the sea floor spread if you prefer. Simply turn to the "Games and Other Nifties" section and put together your own flip book.

P.S. This is a very slow dance . . . would you believe 200 million years!

MAKING MINIATURE SOIL PROFILES

The soil near your home and school can be studied and displayed by making a miniature profile. This consists of taking small soil samples of each horizon and mounting them on a piece of cardboard. Locate an area where the soil is exposed, such as along a road cut, near the edge of a stream, or near a gully. Shave the soil off with a shovel to produce a flat, vertical profile. Now you are ready to make a miniature soil profile. You'll also need:

soil sampler (half of an aspirin box with a small hole punched through it)
glue
cardboard chips the size of the aspirin box
large piece of cardboard or plywood

Follow these directions to make the soil profile:

(1.) Place a cardboard chip in the bottom of your soil sampler.

(2.) Spread some glue on the cardboard chip.

(3.) Press the sampler into a chunk of soil taken from the uppermost horizon.

(4.) Break off excess earth with your pocket knife, leaving a natural surface about the thickness of the sampler depth. Do not cut the sample off even with the edges of the sampler, as the process of cutting destroys the natural appearance.

(5.) Push the tip of a pencil through the hole in the sampler to remove the sample.

(6.) Draw the soil profile to scale on the mounting board to show the relative thickness of each horizon.

(7.) Glue your sample to the center of the area of the mounting board.

(8.) Repeat the procedure, taking samples every 20 to 30 cm or wherever there is a distinct change in the profile. Glue each sample directly below the previous chip.

We recommend that you prepare your soil profiles on plywood. If you stain the wood and spray the soil chips with a clear paint, you will have a beautiful art display. Also, if you make these miniature profiles from different areas, each will be different.

Based upon "Making a Miniature Soil Profile" in *Field Guide to the Soils* by Henry Foth and Hyde S. Jacobs. Boston: Houghton Mifflin. Copyright © 1971 by the American Geological Institute.

SIR CHARLES LYELL, GEOLOGIST

Charles Lyell was born in Forfarshire, Scotland, in 1797. While at Oxford studying law, he became interested in geology, and in 1819 he became a fellow of the Geological Society.

After passing the bar exam, Lyell became a circuit lawyer and traveled through France and Italy. As he continued to observe earth processes during his travels, he gradually became convinced that James Hutton's geological theories were correct. [Hutton (1726–1797), a Scottish physician and student of nature, spent over 30 years studying rock formations and sediments. He concluded that rocks formed in a layer-by-layer fashion. The oldest rocks would be found at the bottom of a pile of sedimentary rocks. He proposed another important idea: His observations convinced him that the processes affecting the earth today also affected the earth in the past.] By 1827 Lyell had already begun to plan his chief work, *The Principles of Geology*, published in 1830.

Lyell felt that the landscape had been created not by a series of catastrophes, as people believed, but rather by slow, continuous earth processes that had been going on since the beginning of geologic time. The same idea had been proposed more than a generation before by James Hutton. Lyell's data supported Hutton's theory, and his three-volume book brought it to the attention of the world.

Through Lyell's careful work, the principle of uniformity of process became widely accepted. In 1838 Lyell published *The Elements of Geology*, now regarded as a classic geologic work. Lyell traveled to the United States and Canada in 1841 and wrote a number of papers about the geologic features of North America before his death in 1875.

(1.) In earlier times fossils were thought to be the remains of the animal and plant life that was killed during geological catastrophes. The world was supposed to have been restocked with organisms after each catastrophe. What do you think about this idea? What do other people think?

(2.) Geology was a hobby at first for Charles Lyell. Do you think people can still have hobbies and make contributions like Lyell did?

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CHAPTER 7

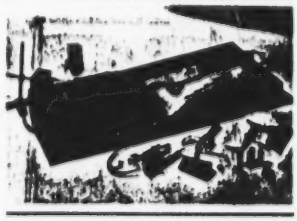
WET AND WILD

Water, water everywhere and not a drop to drink. Well, let's hope this isn't the case. Earth is a water planet. Three-fourths of the surface of our planet is covered with water. Oceans, lakes, rivers, and streams flow over the surface. People journey to the shores of oceans and lakes for recreation, much of the world's food comes from the water, and without the precious supply of water most forms of life would not exist. Explore the wet and wild, and appreciate this most important resource.

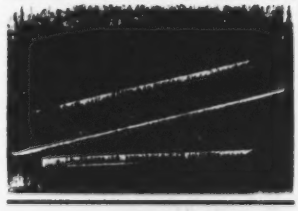
STREAM TABLES

A stream table is a waterproof box containing water, dirt, sand, and gravel. It can be used to study the behavior of rivers and streams, lakes, ocean waves, beaches, dams, and anything else you can think of.

Complete Earth Science Stream Table
69050 $149.20
This 5 foot long stream table will do everything you've always wanted a stream table to do and more. Would you believe a wave generator to make your own ocean waves and a recirculating pump to eliminate the bucket brigade? Available from Science Kit.

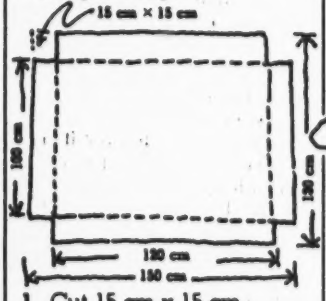


Stream Table Kit
66037-01 Single Kit $15.50
This inexpensive stream table is great for studying soil erosion and landscape development. This 4 foot long table can be used to study the wet 'n' wild motions of streams and . . . it packs a lot of power. Available from Science Kit.

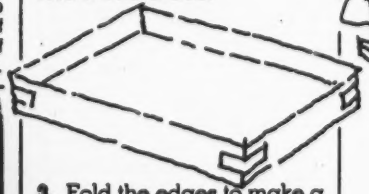


YOUR EVERYDAY SUPER STREAM TABLE

YOU WILL NEED:
heavy cardboard (tri-wall) 150 cm x 130 cm
two layers of heavy polyethylene sheeting (4 mil mylar is recommended) — you'll need sheets 1 meter longer than the table
waterproof tape

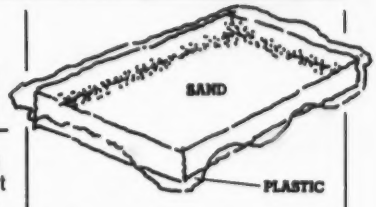


1. Cut 15 cm x 15 cm sections out of the four corners of the heavy cardboard.
2. Score the heavy cardboard as shown in the illustration so that you can fold it into a box.



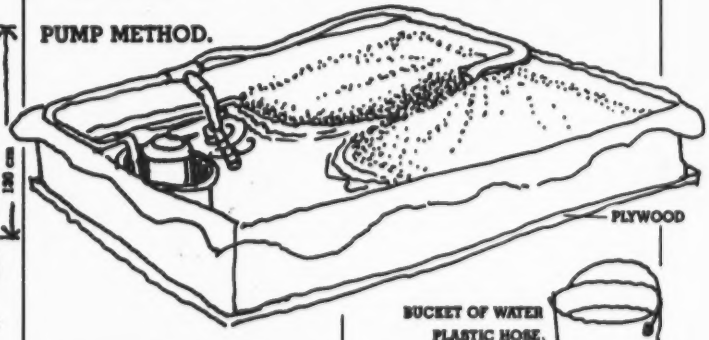
3. Fold the edges to make a box. Tape the corners using waterproof tape. The tape must be strong, so use a heavy variety.

4. Cut the plastic sheet 2½ feet longer than the box. Put both liners in the box, one on top of the other. Put a handful of wet sand in each corner and along both sides so that the sheet fits tightly. Fold each corner into a neat corner, and tape the plastic to the box on the outside.

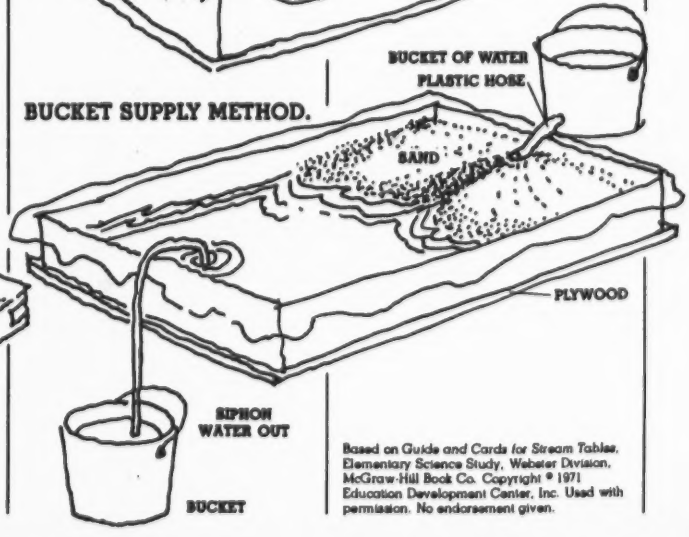


5. Your completed stream table is now ready for use. To study river motion you need to get water moving downhill. You can use the pump method or the bucket supply method.

PUMP METHOD.



BUCKET SUPPLY METHOD.



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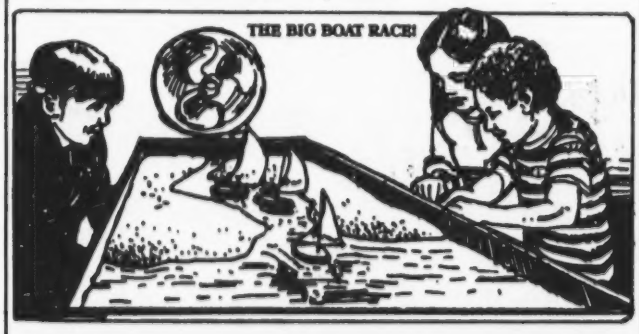
STREAM TABLE ACTIVITIES

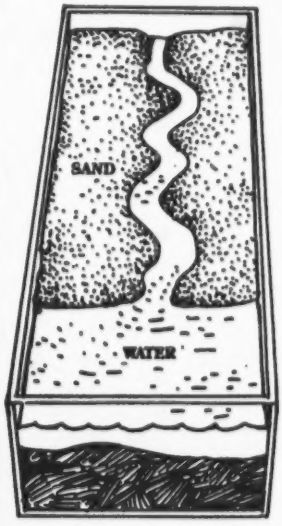
Boat Racing
Why not! Everyone designs his or her own sailboat. To make it challenging, give everyone the same size piece of aluminum foil and a small wood dowel. A small fan placed at one end of the stream table can be a source of wind. Run it at low speed.

Can you:
Design a boat that will sail into the wind?
Design a boat with a rudder that is maneuverable?
Design a sailboat with more than one sail?
Design a boat that will hold more than its own mass?



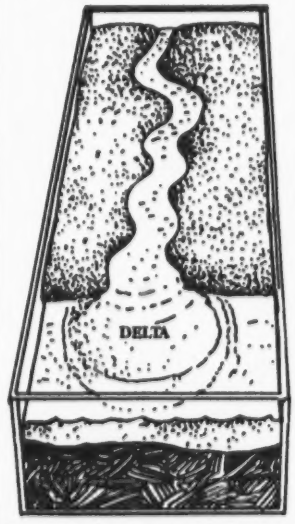
THE TRAY-AND-BOTTLE STREAM TABLE

A final stream table operation is the cheapest and smallest, yet it is a workable method. All you need is a squeeze bottle and a tray (a baking tray will do) and you're off!



Streams
1. Which stream will flow the fastest?
   a. Will a 3 foot stream beat a 10 foot one?
   b. What happens if you tilt the table?
2. How large a stone can a stream move?
   a. Does it matter if the stream is straight or winding?
   b. Does it matter if the stream is slow or fast?
   c. What if the table is tilted?
3. If you start a stream in mixed sand, where do the different grain sizes go?
   a. How does the shape of the stream change as the water goes through different sand layers?
   b. What if you tilt the table?
   c. What happens if you leave it tilted, then lower it?
4. If you build streams using different grain sizes of sand for each stream, which sand gives you the steepest banks? What if you tilt the table?
5. Can you build a very winding stream?
   a. What can you do to straighten it out?
   b. What happens if you tilt the table?
   c. Does it matter what kind of sand you are using?

Deltas
1. How can you form the widest possible delta at the mouth of a stream?
   a. Can you add something to a stream to change a delta?
   b. If you tilt the table, what happens to the delta?
2. Can you make deltas at different places along a stream?
3. Can you make deltas with
   a. both winding and straight streams?
   b. different barriers across the stream?
   c. steps of sand along the stream?
   d. different tilts to the table?
   e. different depths of water around the pump?
   f. more sand and less water?
   g. more water and less sand?



Activities based on "Questions" in Guide and Cards for Stream Tables, Elementary Science Study, Webster Division, McGraw-Hill Book Co. Copyright © 1971 Education Development Center, Inc. Used with permission. No endorsement given.

Lakes

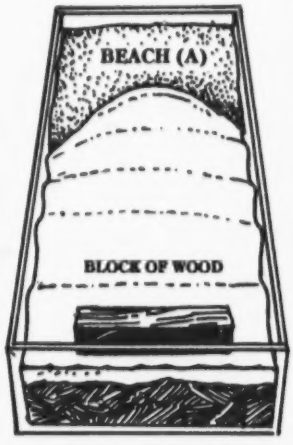
1. What happens if a stream enters a lake without an outlet?
2. How long does it take a lake to empty?
3. What effect does the stream water entering a lake have on the temperature of the lake?

Beaches

Set up your stream table as shown for beach A.

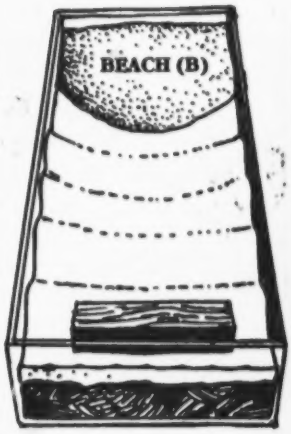
You can now study the effect of ocean waves on beaches.

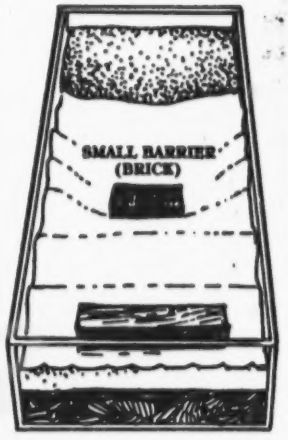
1. How do gentle waves, compared to storm waves, affect a beach?
2. Is a beach formed in both situations?
3. What happens to the beach if the waves come in at an angle?



Push down gently on wood blocks to generate waves. Pushing down at a faster rate will allow you to increase the frequency of the waves. Pushing harder will allow you to change the size of the waves.

4. Mold your beach first as in A and then as in B. What pattern do the waves show when they hit the beaches?
5. What happens to waves when they reach a barrier?
6. When a stream flows into an ocean, what happens to the delta?
7. What happens to the delta if you make the ocean waves go straight at the mouth of the stream?
8. What happens to it if you change the angle of the waves?

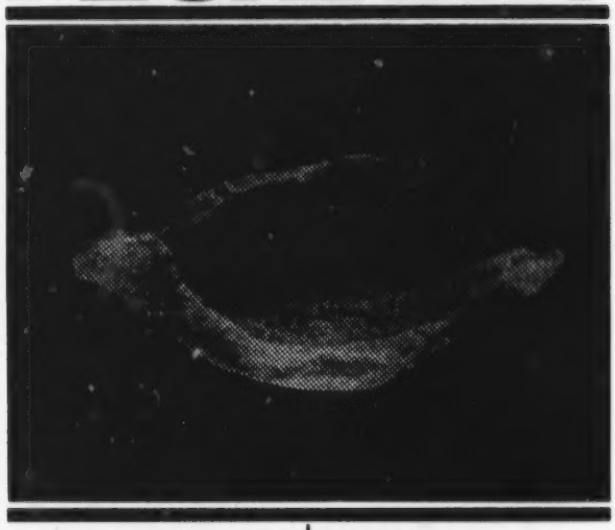




Some Additional Ideas

1. Obtain a topographic map of an area and try to build a model of the area using the stream table.
2. Make relief maps (show hills and valleys) and then have others draw maps of your models.
3. Simulate an oil spill in an ocean along a beach. What is the best method you can discover for cleaning up the mess?
4. Put colored dye into the water. Study the currents in water motions.
5. Use a Polaroid camera to photograph the experiments you do.
6. Study the effects of various landscape and conservation techniques. Do these techniques reduce erosion?

FLOATERS



Can you get something that is more dense than water to float? Could you get a ball of modeling clay to float?

You will need

28 g (about 1 ounce) of modeling clay (plasticine or clay-cene)
roll of aluminum foil
large plastic bowl
100 marbles

Clay Float

1. Roll you clay into a ball.
2. Fill your container half full of water.
3. Carefully put your ball of clay on top of the water. Does it sink or float?
4. Now try to make your clay into a shape that will float.
5. Make a drawing of your floater.

6. Find out how many marbles your floater can hold without sinking.
7. Make a lot of floaters, using a different design for each.

Aluminum Float

1. Cut a square of aluminum that is 15 cm (about 6 inches) on each edge.
2. Try to get the foil to float. Experiment with lots of different shapes.
3. How many marbles can the different shapes hold without sinking?

From *Teacher's Guide for Clay Boats*, Webster Division, McGraw-Hill Book Co. Copyright © 1969 Education Development Center, Inc. Used with permission. No endorsement given.

SOME WET AND WILD BOOKS

A Day and a Night in a Tide Pool by Mary Adrian. New York: Hastings House, 1972, $4.95.

Estuaries: Where Rivers Meet the Sea by Laurence Pringle. New York: Macmillan, 1973, $4.95.

From Shore to Ocean Floor by Seymour Simon. New York: Franklin Watts, 1973, $4.95.

Lakes by Delia Goetz. New York: Morrow Junior Books, 1973, $3.95.

MESSING ABOUT IN SAND

If you are like us, you've messed about in sand at one time or another. If you haven't, then here is your chance!

Sand Coloring

Obtain fine, white sand. You will need to use all-purpose dye, food coloring, or tempera paints to color the sand. Experiment with different amounts of dye and sand until you obtain the colors you want. Follow these directions.

Sand Painting

Using a pencil and a sheet of oaktag, draw an outline of the picture you want. Put glue on those parts of the drawing that will all be the same color. Sprinkle the sand on and let it dry for a few minutes. Shake off the excess sand. Now put glue on all the parts that will be a second color and sprinkle these parts. Continue glueing and sprinkling sand until the picture is complete.

Sand Sculpture

Mix together two parts sand, one part cornstarch, and one part water. Heat the mixture until the cornstarch thickens and then let it cool until it can be handled. You can use colored or uncolored sand. Varying the size of the grains of sand will give you more variety.

Making Sandpaper

Cut pieces of oaktag to various sizes. Spread white glue over the entire surface. Sprinkle sand on the paper in any amount you wish and you have sandpaper.

Commercial sandpaper comes in various grades, from very fine to very coarse. To make different grades of sandpaper you will have to separate the sand into different sizes. To make the job easier use shoe boxes to make sorting machines.

Here are some questions you can answer if you have messed around with the sandpaper:

1. ***What happens to things you sand?***
2. ***What happens to the sandpaper?***
3. ***Are there other materials that can be used to make "sandpaper"? How about sugar, salt, rice, or cereal seeds?***
4. ***How does your "sandpaper" compare to store-bought sandpaper?***

Based on pages 33, 35, 37, and 38 in Teacher's Guide for Sand, Elementary Science Study, Webster Division, McGraw-Hill Book Co. Copyright © 1970 Education Development Center, Inc. All rights reserved. Used with permission. No endorsement given.

SHELL COLLECTIONS

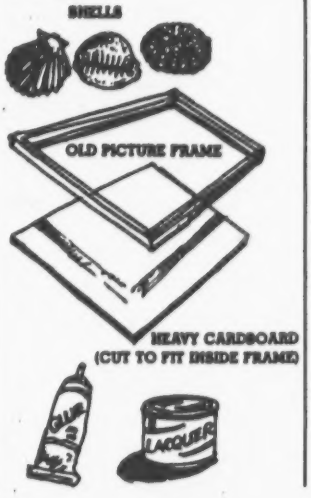
These two activities require that you have a collection of shells. Preferably you will collect a set from a local beach.

Identification

Sort your collection into like groups. The shell animals that live in water environments are called *mollusks*. There are four types shown in the illustration. Check to see if your groups resemble the animals shown.

Display

After you have grouped and identified the shells, you can display them. One idea is a shell board. You can construct shell boards for each place that you collect shells from. To do this you will need:



1. Tack the cardboard inside the picture frame.
2. Group the shells by class based on the identification you made earlier. Glue them in place on the shell board. You can varnish or lacquer the shells if you wish.
3. Mount the completed shell board on a wall for display.

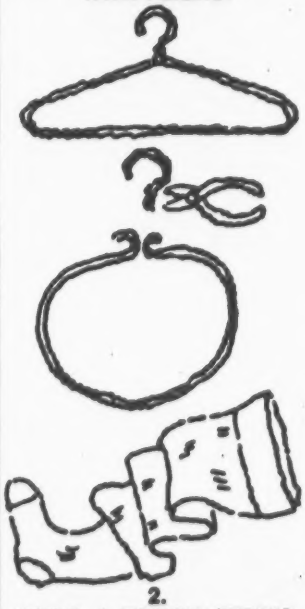
SEA ANIMAL BOOKS

Aquariums by John Hoke. New York: Franklin Watts, 1975, $3.90.
The Changeable World of the Oyster by Joseph J. Cooke. New York: Dodd, Mead, 1974, $4.25.
Sea Water Aquaria by L. A. J. Jackman. Cranbury, N.J.: Barnes, 1974, $7.95.
The Seals by Nancy McGowan. Austin, Texas: Steck-Vaughn Co., 1975, $4.68.
Seashells in Action by Audrey Newell. New York: Walker, 1973, $4.95.
The Strange World of Sea Mammals by William Wise. New York: Putnam's, 1973, $5.86.

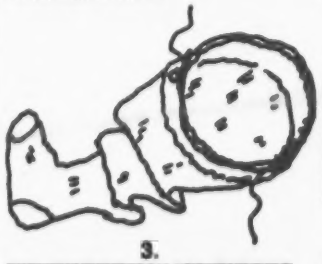
MAKING A TINY NET FOR PLANKTON

YOU WILL NEED:
WIRE COAT HANGER
OLD NYLON STOCKING
PLIERS
SCISSORS
SMALL JAR (MOUTH 3 CM IN DIAMETER)
CORD
STRING
SWIVEL

1.
BEND THE COAT HANGER INTO A CIRCLE. TWIST THE ENDS TOGETHER WITH PLIERS.



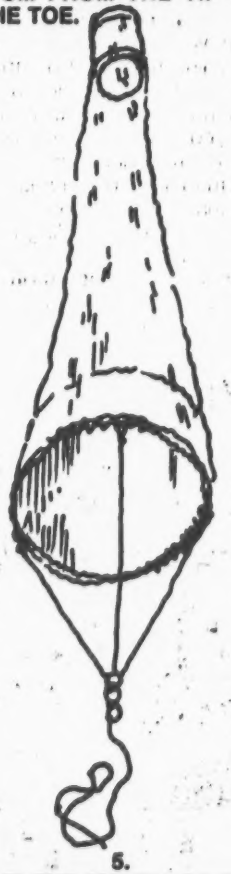
2.
USING A TOUGH STRING, SEW THE TOP OF THE STOCKING TO THE COAT HANGER RING.



3.
TIE THREE 30 CM PIECES OF STRING TO THE RING.

4.
TIE THE OTHER ENDS OF THE STRINGS TO ONE END OF THE SWIVEL. TO THE OTHER END OF THE SWIVEL ATTACH THE CORD, WHICH WILL BE USED TO PULL THE NET.

CUT THE END OF THE STOCKING OFF AT ABOUT 5 CM FROM THE TIP OF THE TOE.



5.
PUT THE MOUTH OF THE SMALL JAR INSIDE THE STOCKING TOE AND TIE FIRMLY IN PLACE. YOUR PLANKTON NET IS READY TO USE.

Adapted from Student-Teacher Environmental Relationships Investigations, DOCK, E.S.E.A., Title III, The Board of Public Education for the City of Savannah and the County of Chatham.

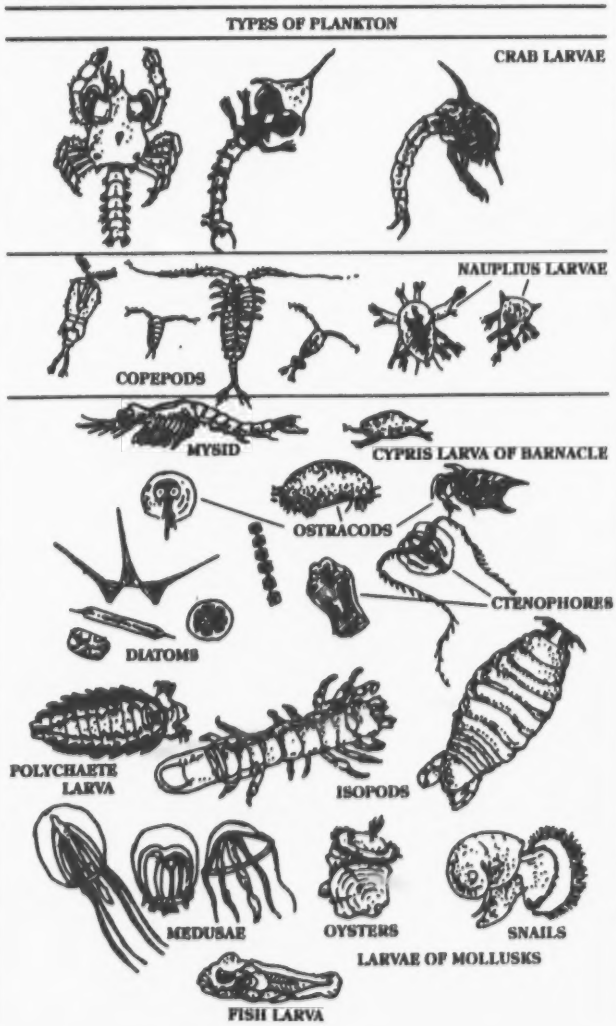
COLLECTING & STUDYING PLANKTON

Plankton are floating organisms that live in the water. You can find them in both fresh and salt water. Plankton come in a variety of sizes. Some, like jellyfish, are visible in the water, but many types, such as diatoms, fish larvae, and isopods, are not. A plankton net is necessary to collect these smaller ones.

To collect the plankton, lower the net into the water and let the line out. Do not let it sink to the bottom. Leave the net in the water for 5 or 10 minutes and then pull it in.

Untie the collecting bottle and pour the sample carefully into a large jar. Place a small sample of the collected material in a petri dish and observe it under a microscope. First observe the varieties of plankton. Make sketches of what you observe. You may want to identify the plankton in your sample using the plankton chart.

How many types of plankton did you find?



The Beach

The beach is a place many people go to, to find peace and solitude. The to-and-fro motion of ocean waves reveals the power and majestic form of the ocean. Read this poem while listening to a record of ocean sounds. When you are finished, here are some things to think about:

1. How do you feel when you are standing on a beach looking out toward the vastness of the ocean?
2. Close your eyes and imagine you are at the ocean. Try to think what it is like and what you see. Write about it.

OCEAN by Julia Griffin

For days
the days have rolled
to greet me
to wrap me in their languid
muck.

I have grown fat
and placid
the rolls rise
to meet my fingers

the night
is hiding.

She does not appear
to sweep me away
on yards of blowing silk
but remains behind the curtain
Elusive; I must have sinned.

words dance through the room
tap me on my head
but are difficult
to capture.

The sunlight plays hopscotch
with the gold carpet
Somewhere the beach rises
to meet the ocean
and awaits my arrival
to drag me down
into its silvery depths.

into the black abyss
I have tumbled,
accompanied by secrets
I forgot to tell.

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SERIOUS PROBLEMS

Our civilization has affected the natural environments near bodies of water, including rivers, lakes, and oceans. Some of these problems have become so serious that many people can no longer swim, some fish are dangerous to eat, and many organisms may have become extinct. Here is a list of problem areas that have resulted from people's tampering with natural habitats.

Rank the problems from most serious (1) to least serious (6). Identify additional problems in your area. If you are working in a group, reach your decisions by consensus.

1. Dredging:
The waste material from dredging has been dumped on marshes. In some cases the marsh has been destroyed and rains have later eroded material to surrounding mud flats. The increasing amount of silt is carried for miles, sometimes killing oysters and scallops.

2. Pesticide pollution:
The use of pesticides has been disastrous to some aspects of the food web. Although there are restrictions on DDT, new pesticides are still increasing these problems.

3. Chemical wastes:
Mercury poisoning has not only killed fish but has had toxic effects on humans. Although it has been difficult to determine that a specific chemical leads to the death of particular organisms, introducing additional chemical products into our waterways will most surely be dangerous.

4. Oil spills:
Oil spills are a dangerous threat to the vitality of our ocean shorelines. Oil is less dense than water and forms a thin layer on the surface of the water, covering everything in sight.

5. Sewage disposal:
Many cities and towns dump raw sewage into their waterways. Coastal and inland waterways are subjected to sewage disposal, and much of what is dumped is not treated.

6. Local problems:

WATER BOOKS

New American Continent — Our Continental Shelf by Norman Carlisle. Philadelphia: Lippincott, 1973, $4.95.

The New Water Book by Melvin Berger. New York: Crowell, 1973, $4.50.

The Story of Oceanography by Robert E. Boyer. New York: Harvey House, 1975, $5.89.

Water for Today and Tomorrow by R. J. Lefkowitz. New York: Parent's Magazine Press, 1973, $3.78.

Water Is Wet by Sally Cartwright. New York: Coward, McCann, and Geoghegan, 1973, $4.39.

JACQUES COUSTEAU, AQUANAUT

Jacques Cousteau was born in France in 1910. When he was young, he didn't especially like school, but during summers he was able to learn English, German, and Spanish. His early life was spent in the French Navy.

While in the navy, he "discovered the ocean" by chance. With a pair of borrowed goggles he entered the ocean and discovered a fascinating new environment. He started experimenting with underwater breathing equipment, and in 1947 he developed one of the greatest underwater diving inventions, the aqualung.

Cousteau's love of the ocean led to intensive studies. His ship, the Calypso, and his divers are world famous. They have lived and explored the ocean world-wide. Cousteau and his aquanauts have studied the behavior of many underwater life forms, and more recently they have studied the pollution of the seas. Cousteau warns that we must maintain the ocean and its life, for its life is our life.

1. Cousteau, as a young person, did not "set out" to become an ocean explorer. "Accidental" experiments during his early twenties got him interested in diving. Ask other adults, not just science people, how they decided what they would do when they got older.

2. Research the explorations of Cousteau's ship and crew.

THE WET & WILD GAME

EXPLORE THE WORLD OF A WATER ENVIRONMENT. PLAY THE WET AND WILD GAME.

TURN TO THE "GAMES AND OTHER NIFTIES" SECTION FOR THE GAME DIRECTIONS.

CHAPTER 8

WHITHER THE WEATHER

Large, wide, high bubbling clouds of white and gray move closer and closer and begin to fill the once-blue sky.

The chirping birds stop their happy songs, the grasshoppers stop jumping, squirrels head for their nests, and everything gets still and calm.

And then, suddenly, from nowhere a leaf-blowing, branch-twisting wind strikes us so hard that we have to turn our backs on it to protect ourselves.

A quick flash of lightning and the explosion of thunder add to the excitement.

One tiny drop of rain manages to find that thin space between our coat collar and neck and then spreads a wet chill down our backs.

The ground-pounding, ear-splitting, sky-filling display of the power of nature makes us feel small and helpless.

We seek safe shelter from the storm and begin our wait for the sun.

KEEPING A WEATHER CHART

Everybody talks about the weather but few people really keep up with the details of the changing weather. One way to follow the changes in the weather is by keeping a daily weather chart.

You can get the information you need by using some of the weather instruments described in this section. Other ways to get information are to listen to daily weather forecasts on radio or television, read the weather forecasts in a daily newspaper, or call the weather bureau number (listed under the "Commerce Department" subheading in the white pages of your phone book under the "United States Government" listing).

Try to gather and record the weather information at the same time each day.

WEATHER CHART

DAYS:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1. Date																															
2. Time																															
3. Temperature (Celsius)																															
4. Barometric pressure																															
5. Relative humidity																															
6. Dew point																															
7. Wind direction																															
8. Wind speed																															
9. Amount of precipitation (rain, snow, sleet)																															
10. Cloud type																															
11. Percentage of sky covered by clouds																															
12. Weather description																															

THE AIR

If you've ever heard a TV weatherman mention high pressure or low pressure, you may have wondered what he was talking about. The pressure or push of the air has a great deal to do with the kind of weather we have. Air pressure is hard to understand because we can't really sense it without special instruments such as barometers. This activity will help you understand air pressure by showing that the air does have a pressure.

You will need:

drinking glass

index card that is wider than the mouth of the glass

some water

1. Fill the glass with water. Be sure that the water is all the way to the top.

2. Put the index card on the top of the glass.

3. Put the palm of your hand on top of the index card.

4. Take the materials to a sink and, with your hand on the index card, turn the glass over.

5. Carefully take your hand away from the card.

If you have followed the directions, the card should be holding the water in the upside down glass. The question now is, why doesn't the card fall off?

The answer is that the air is pushing on each square inch of the card with a greater force than the water. As a matter of fact, the air pushes in all directions with a force of about 15 pounds per square inch.

MAKING A BAROMETER

The pressure of the air can be measured using a barometer. In this activity you will be building an *aneroid* barometer. It will give you a general idea of whether the air pressure is rising or falling. If you want a more accurate measure of air pressure, you will need to listen to weather reports or use a commercially made barometer.

Materials

Two olive jars or baby food jars

scissors

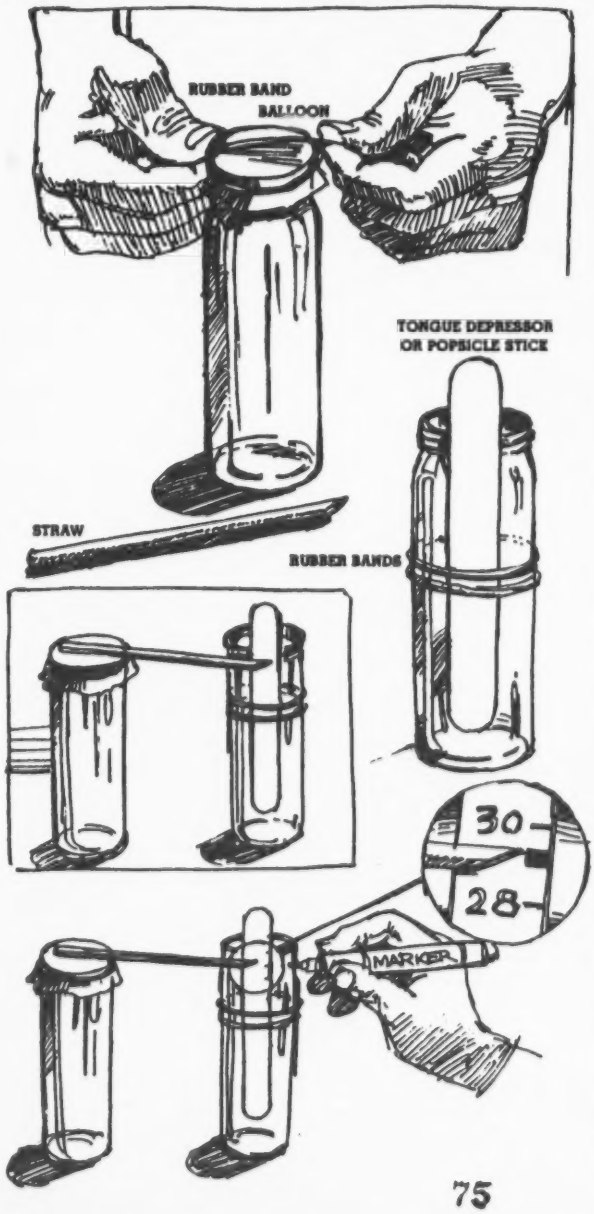
balloon

tongue depressor or Popsicle stick

glue (use mucilage, not rubber cement or plastic cement)

plastic straws

rubber bands



Directions

1. Cut a large section from the balloon and stretch it tightly over the mouth of one of the bottles.

2. Have someone place a rubber band around the section of balloon so that it is held tightly in place.

3. The straw will be the pointer that will indicate changes in the pressure. Cut the end of the straw so that it forms a point.

4. Put a dab of glue on the center of the balloon and put the nonpointed end of the straw on the spot of glue. Try to hold the straw still while it dries.

5. The tongue depressor or Popsicle stick is going to be used as the scale. Using rubber bands, fasten the stick to the other jar.

6. Now put the jars close enough to each other so that the point of the straw is alongside the Popsicle stick.

7. With your marking pen, make a mark on the Popsicle stick at the place nearest the pointer.

8. Call the weather bureau to find out what the air pressure is and write it on the Popsicle stick.

9. Check your barometer every day for three or four days and notice any change in the position of the pointer. Call the weather bureau each time and write the new readings on the barometer.

From now on you'll be able to estimate the air pressure by looking at your barometer. Remember that your barometer is only giving a very rough measure of the air pressure pressing on the top surface of the balloon. For very accurate barometer readings you will need to check with the weather bureau.

Here are some hints to help you use your rough barometer well:

1. Set it up in one place indoors; try not to move it.

2. Put it in some part of the room that does not change in temperature very much. (Changes in temperature will change the pressure reading.)

3. Do not move your barometer after you have set it up.

MOISTURE IN THE AIR

Have you ever heard anyone say, "It's not the heat that bothers me, it's the humidity"? Humidity is a measure of the amount of water in the air compared to the amount of water it could hold. Water that is in the air is invisible to us except when it clumps together to take the form of rain, snow, fog, or clouds.

We can learn more about this invisible water that is in the air (which we call water vapor) by doing a simple experiment.

Materials

tin can
crushed ice (if you can't get crushed ice, wrap ice cubes in heavy toweling and hit them with a hammer)
thermometer
water

Directions

1. Take the label off the can and wash the outside of the can thoroughly. Dry the can, and, with a soft cloth or paper towel, rub the outside until it is shiny.

2. Fill the can half full of water.

3. Put the thermometer in the can.

4. Carefully add ice to the water, being sure to keep the ice from hitting the thermometer.

5. Keep an eye on the outside of the can. Add the crushed ice slowly until you see the outside shiny surface of the can become covered with a thin film of water.

Where did this water that gathered on the outside of the can come from?

What was the temperature at which the water formed, or "condensed," on the outside of the can?

Through this experiment you have found a way to make some of the invisible water vapor in the air gather together to form droplets on the side of the can.

The temperature at which the water vapor that was in the air became water droplets is called the "dew point."

WHAT GOES UP MAY NOT COME DOWN

The pressure of the air is strong enough to help you do something that works against gravity and common sense.

You will need a drinking glass and a bucket, deep bowl, or sink you can fill with water.

1. Fill the large container with water.

2. Put the drinking glass in the water.

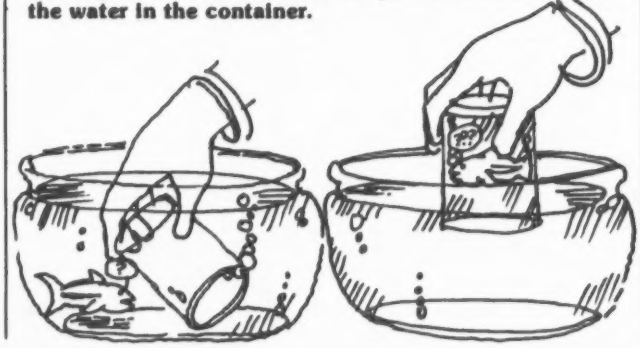
3. Push the glass under the surface of the water and lay it on its side.

4. When the glass is under the water and completely filled, turn it over so the mouth of the glass faces down.

5. Hold the bottom of the glass and start to pull it out of the water. Stop when the glass is about 1 inch from being completely out of the water.

Notice that the water in the glass is higher than the water in the large container. What is keeping the water up?

Hint: There is very little pressure on the water that is in the glass. There is a lot of air pressure on the top of the water in the container.



HOW DOES WATER GET INTO THE AIR?

Clouds, rain, snow, and fog are all formed from the water vapor that is in the air. In this activity you'll see how the water vapor gets into the air in the first place.

Materials

three drinking glasses of the same size
marking pen
water

Directions

1. *Fill all three drinking glasses about three-fourths full of water.*

2. *Line the glasses up and add or subtract water from them until they all have the same amount.*

3. *Using the marking pen, draw a line at the water level on the outside of each glass.*

4. *Put one glass in a warm place, one in a cold place, and one in a place that is at normal room temperature.*

5. *For two or three days check the water levels in the glasses You can mark the levels each day with the marking pen.*

Which glass lost the most water?
Which glass lost the least water?
Where did the water go?
Where does the water vapor in the atmosphere come from?

INDOOR RAINMAKING

This activity will help you understand how rain is formed.

Materials
- **teakettle**
- **stove or hot plate**
- **large pot (or cookie sheet)**
- **ice cubes**
- **water**

Directions

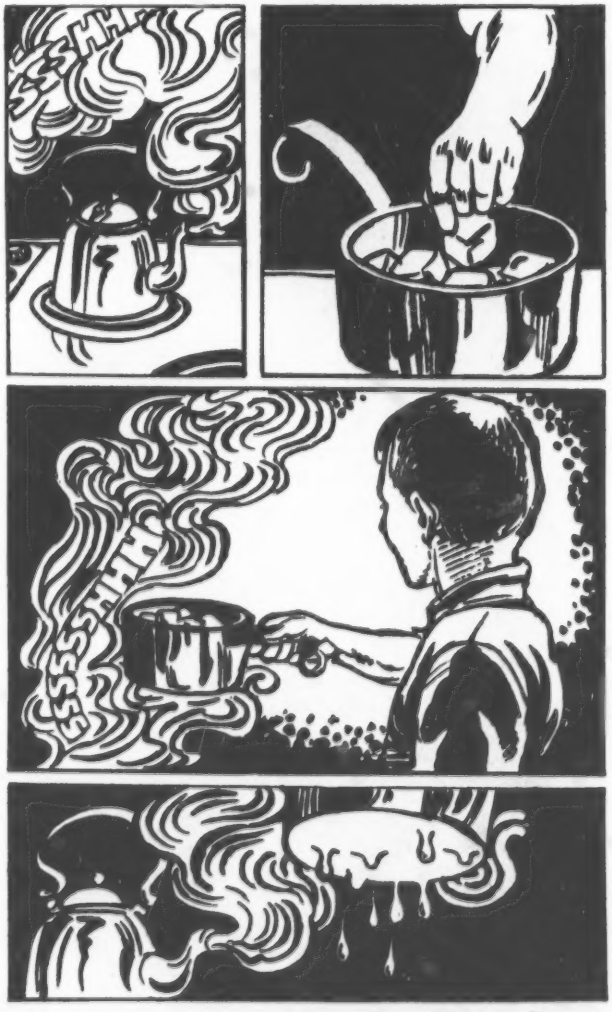
1. Fill the teakettle with water and heat it until it boils.

2. Put ice cubes in the pot.

3. Hold the pot containing the ice about 5 inches from the teakettle spout. Be sure the spout is aimed away from you or anyone else since the steam is very hot.

4. Let the steam from the teakettle strike the bottom of the pot containing ice.

5. Watch the bottom of the pot. Eventually you'll see water droplets begin to form on the bottom surface of the pot. When the droplets get big enough, they will fall like raindrops.



MAKING A RAIN GAUGE

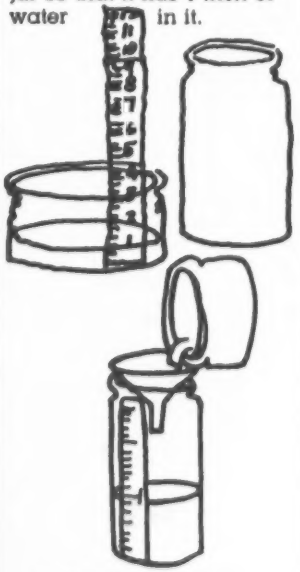
This is a very simple way to measure the amount of rain that falls. Since the heaviest rainstorm is unlikely to drop more than an inch of water on the earth's surface, you will be building a rain gauge that can measure quantities of less than an inch.

Materials
- wide-mouth jar with straight sides
- long, narrow jar with straight sides (such as an Alka-Seltzer or olive jar)
- foot ruler
- marking tape
- plastic or metal bucket
- kitchen funnel
- marking pen

Directions

1. Remove the paper labels from both jars by washing them with hot soapy water.

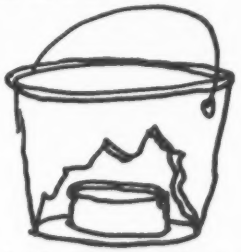
2. Fill the wide-mouthed jar so that it has 1 inch of water in it.



3. Place a strip of masking tape lengthwise on the tall, thin jar beginning at the very bottom of the jar.

4. Pour the inch of water from the wide-mouth jar through the funnel into the tall, narrow jar.

5. If you are using inches, mark the distance from the top of the water to the bottom of the tall jar in tenths. In other words, place ten equally spaced lines from the bottom of the jar to the top of the water. Continue making lines on the tape the same distance apart right to the top of the jar. This tall, narrow jar is your measuring jar.



6. The wide-mouth jar is your collecting jar. Place it in the bucket and put the bucket outdoors where it won't be disturbed.

7. After a rainfall take your measuring jar outside and pour all the water that has gathered in the wide-mouth jar into it.

8. Read the level of the water in the measuring jar as so many tenths of an inch.

9. Use this scale to convert your rainfall measurements into metric measurements.

INCHES OF WATER	CENTIMETERS OF WATER
1.5	3.75
1.4	3.50
1.3	3.25
1.2	3.00
1.1	2.75
1.0	2.50
.9	2.25
.8	2.00
.7	1.75
.6	1.50
.5	1.25
.4	1.00
.3	.75
.2	.50
.1	.25

WINTER THOUGHTS AND FEELINGS

"Winter"
Julia Griffin

Gleaming
from the raw-toothed
Sun; i rise

under my dense
of hair; the clogged drain of

my open-mouthed wonderings.
Constant interaction
with these hollow-faced
Clods —

is like
radical surgery. Buildings glare
in their omnipresence — placid

in stupidity's clutches,
i twist and rave; turning
turning in the maze

a spider caught in her web.

no knowing,
only blowing wishes
to eloquent, pink-toed winds,

how these days loom
Scanty and blue
in winter's grasping touch.

"Winter" © 1970 by Julia Griffin. Used with permission.

Read the poem "Winter" before answering any of these questions.

1. How does winter make you feel? If you're reading this during another season, fantasize about winter or answer the same question for the season you are experiencing.
2. Make a list of things that happen to life processes during the winter. Make similar lists for the other seasons. How does winter differ from the other seasons in this respect?
3. What are the differences in your feelings as you watch life change from season to season?
4. Go for a long walk. During the walk, bring yourself to a level of awareness so that you are actually "into" the season.

After being into this awareness, write whatever thoughts come into your head. (Psst! No editing — don't worry about grammar, just let the thoughts come through.)

VILHELM BJERKNES, SUPER WEATHERMAN

Vilhelm Bjerknes (1862–1951), a Norwegian physicist, by 1912 had become recognized as the founder of modern physical hydrodynamics, the study of forces and motion in fluids. In that year, on being named Director of the Geophysical Institute at the University of Leipzig, Bjerknes announced a new goal. He would consider his task done, he said, if in one year he could correctly calculate the change of weather during one day. "It may take a year to dig a tunnel through a mountain," he pointed out, "but later, others may make the passage with an express train."

In 1917 Bjerknes returned to Norway to establish a geophysical institute at Bergen. There, with his son, J. Bjerknes, and Halvor Solberg, he laid the basis for a revolution in weather forecasting. During World War I, Norway was cut off almost completely from weather reports outside Scandinavia. Bjerknes was successful in establishing a network of many weather observing stations located close together along the Norwegian coast. His plan was to analyze the reports from this small network of stations intensively, applying his theories of fluid motion. Other young Scandinavian scientists joined the Bergen group. They would work enthusiastically far into the night, when Vilhelm Bjerknes might look into the map room with his eyes gleaming and ask, "Are there any new discoveries tonight?"

1. **What do you think of people who work "far into the night"?**
2. **What kind of person do you think Vilhelm Bjerknes was?**

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CHAPTER 9

MAGIC WITH MOLECULES

Chemistry is that part of science that deals with the combining of atoms of different elements to form molecules and the taking apart of these molecules. Although the actual molecules of a material are too small for us to see, there are many experiments that can be done that will make chemical reactions visible. The experiments in this chapter can be done with things that can easily be found at home, in grocery stores, or in drugstores. A good chemist is a careful scientist who makes sure that he or she is safe from any accidents that may happen during a chemical experiment. Be sure to follow the safety precautions listed in this section so that you and your friends have an enjoyable and safe time as you work.

CLOUDING THINGS UP

Here is a way for you to see how something in your breath reacts with limewater.

Materials

½ liter (about a pint) of limewater (which you can get at any drugstore)
glass
straws

Directions

1. Put about 2½ cm (about 1 inch) of limewater into the bottom of the glass. Does it look fairly clear?

2. Put the straw into the glass and blow through it. (Don't suck the limewater into the straw.) As you do this, keep checking the limewater. Does anything happen to it?

What gas in your breath causes the change in the limewater?

Write your answer here and check it below.

Have others try this experiment but use a fresh, clean straw each time. When you are done, throw away the leftover limewater.

Answer: CO_2

THE BALLOON BLOWER UPPER

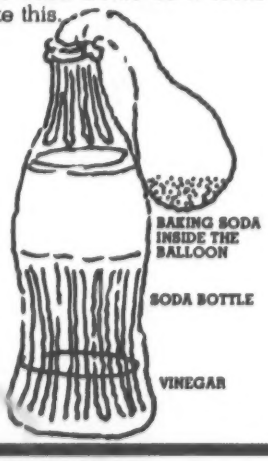
Here is an experiment you can do with a balloon, a soda bottle, and two things you can find in the kitchen: baking soda and vinegar.

1. Blow up the balloon a few times. Do this until the balloon becomes easy to inflate.

2. Put 1 tablespoon of baking soda into the balloon.

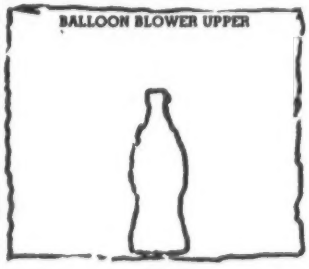
3. Put 3 tablespoons of white kitchen vinegar into the soda bottle.

4. Now put the balloon on the soda bottle so it looks like this.



5. Pick up the balloon so the baking soda goes into the vinegar.

6. Make a drawing of what happens.



The gas that was made when the baking soda and vinegar were mixed is called carbon dioxide. The shorthand way of writing carbon dioxide is CO_2. Can you guess what the shorthand way of writing carbon monoxide is? *(Hint: The "mono" means "one.")* Put your answer here.

Check your answer below.

Answer: CO

THE FIZZER

The medicines that people take are really combinations of chemicals. In this experiment, you'll be able to study the effect of temperature on a chemical reaction.

Materials

three Alka-Seltzer tablets
small baby food jar

Directions

1. Fill one jar half full of water that is at room temperature.

2. Drop in one Alka-Seltzer tablet. What happens?

3. Now rinse out the jar and fill it half full of hot tap water.

4. Drop in one Alka-Seltzer tablet. What happens? How does the reaction in hot water compare with the reaction of water at room temperature?

5. Rinse out the jar and fill it half full of water that is ice-cold. (Fill a glass with ice cubes and water and let two minutes go by. Then pour the water into the baby food jar.)

6. Drop a tablet of Alka-Seltzer into the jar. What happens? Does the chemical reaction of Alka-Seltzer and water depend very much on temperature?

7. Be sure to put any leftover Alka-Seltzer tablets out of the reach of very young children.

AN "EGGSACT" EXPERIMENT

An eggshell is really made of three things: carbon, calcium, and oxygen. If you add vinegar (an acid) to tiny pieces of shell, you can cause a chemical reaction to happen.

Materials

porcelain cup
tablespoon
five eggshells
white kitchen vinegar
baby food jar or small drinking glass

Directions

1. Rinse the eggshells in water until all the egg comes off.

2. Put the eggshells on a paper towel and put the towel in a warm place.

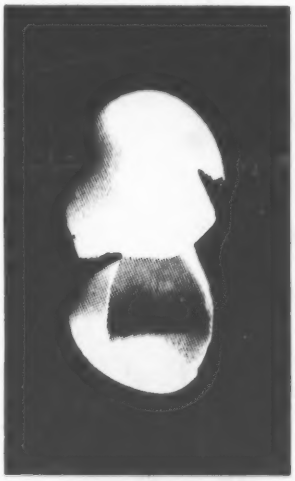
3. When the shells are dry, break them up and put them into the cup. Using the back of the tablespoon, crush the eggshells until you've made a powder.

4. Fill the drinking glass or bottle half full of vinegar.

5. Sprinkle the eggshell powder into the vinegar.

6. Watch the liquid for a few minutes. Draw what you observe. Are any bubbles produced? If so, what do you think is in them? (Hint: The gas is not oxygen.)

7. Throw all the materials away when you are done.



MOVING MOTHBALLS

Here is an experiment in which a gas produced in a reaction gets put to work.

Materials

large drinking glass or olive jar
baking soda
white kitchen vinegar
four mothballs

Directions

1. Fill the glass or jar three-fourths full of water.

2. Stir in 2 tablespoons of baking soda until it all dissolves.

3. Add 2 tablespoons of vinegar to the water.

4. Drop the mothballs into the glass.

5. What do you see happening? Write about what you see going on.

Most of the bubbles you see are filled with carbon dioxide. Where do you see it coming from?

Do you see the bubbles being caught on the edges of the mothballs?

What happens to the bubbles when the mothballs reach the top surface of the liquid?

How long does the movement of the mothballs last?

When the reaction stops, throw all the materials away and be sure to put any extra mothballs out of the reach of young children.

Indicators

A chemical that can be used to tell whether certain other chemicals are present is called an *indicator*. Chemists add indicators to solutions and watch for color changes. The color that the indicator turns tells the chemist something about the solution. Here are some indicators you can use to find out about solutions.

Materials

four small baby food jars or test tubes
teaspoon or medicine dropper
baking soda
cream of tartar powder (which you can buy at the grocery store)
white vinegar
limewater (which you can buy at the drugstore)
red cabbage juice*

Directions

1. The solutions you are going to test should each be placed in a baby food jar. Fill the jars about half full. To make solutions from the two powders, dissolve about a tablespoonful of each in separate jars of water.

2. Using your teaspoon, add a little red cabbage juice to each jar and watch the juice as it enters the solution. Keep track of what happens on the chart.

Red cabbage juice turns red in acid solutions and green or bluish in alkaline solutions. Which of the solutions are acids? Which are alkalis?

**making red cabbage juice*
1. Chop up about one third of a red cabbage.
2. Add ½ liter (about 1 pint) of water and boil the mixture. Smash the cabbage leaf pieces down as you boil them. The "juice" is the purple water you have left after you boil the cabbage.

WHAT HAPPENED?

Substance	Color Change	Acid or Alkali
Baking soda		
Limewater		
Cream of tartar		
White vinegar		

LITMUS PAPER INDICATOR

An indicator that chemists use to tell whether a solution is an acid or an alkali is *litmus paper*. Blue litmus paper will turn pink or reddish when it is dipped in an acid. Red litmus paper turns bluish when it is dipped in an alkali. You can buy litmus paper in a drugstore.

Here are some experiments you can do using litmus paper as an indicator.

Materials

blue litmus paper
red litmus paper
vinegar
lemon juice
baking soda
limewater

Directions

1. Test the vinegar, lemon juice, and limewater with blue litmus paper and red litmus paper.

2. Dissolve a tablespoon of baking soda in ½ cup of water and then test it.

3. Keep track of what you find by using this chart. Which solutions are acids? Which are alkalis?

4. Try your litmus paper indicator with other solutions you find around the house or at school.

WHAT HAPPENED?

Substance	Red Litmus	Blue Litmus	Acid or Alkali
Vinegar			
Lemon juice			
Baking soda			
Limewater			

IODINE INDICATOR

Iodine can be used to find out if something contains starch. Iodine will turn blue or purple when it is mixed with a starch. Iodine is a poison, so be very careful with it. Be sure to keep it out of the reach of young children. Never taste it and always keep it away from your eyes.

Materials

Iodine solution
medicine dropper
cornstarch
sugar
salt
flour
ground chalk
four baby food jars

Substance	What happened when you added iodine?	Is there starch present?
Cornstarch		
Flour		
Salt		
Chalkdust		

Directions

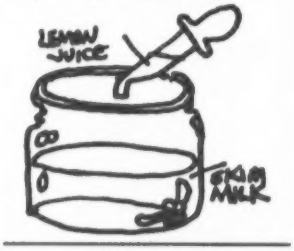
1. *Put a teaspoonful of each of the powders into separate jars.*
2. *Add warm water so that each is half full. Stir each powder into the water.*
3. *Add a drop of iodine to each of the solutions.*
4. *Keep track of what happens on the chart.*

CHEMICAL CHANGES

Here are six experiments that will give you a chance to observe chemical changes.

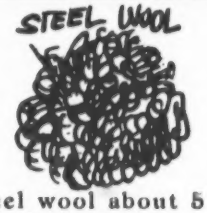
Curdling Milk

Fill a baby food jar half full of skim milk. Add a few drops of lemon juice to the top surface of the milk. What do you see happening?



Rusting Steel Wool

Put about 2½ cm (about 1 inch) of water in the bottom of a glass. Make a ball of



steel wool about 5 cm (2 inches) across. Moisten it and then put it into the bottom of the glass containing water. Make a second ball of steel wool and put it into the bottom of a dry glass. Compare the glasses after a few days. What do you observe? Do you think water is needed in order for the changes to happen?

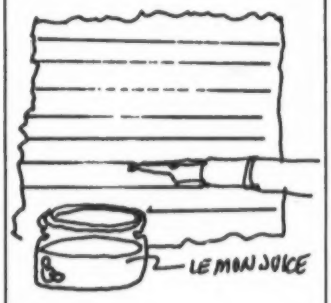
Reaction — Wet or Dry

Put a teaspoon of boric acid powder (which you can get in a drugstore) into the bottom of a dry glass. Now add a teaspoon of baking soda and stir them together. Does anything happen?

Now add 2 teaspoons of water. Does anything happen? Do you think water is needed for this chemical reaction to take place?

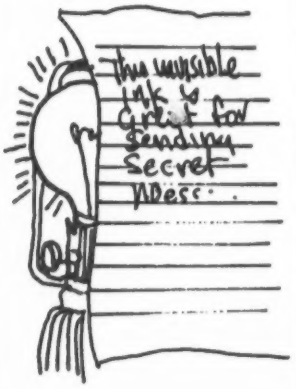
Making Some Invisible Ink

Squeeze the juice from half a lemon into a dish. Dip a toothpick into the lemon juice and then write on a piece of paper using the lemon juice as "ink." Be sure to use plenty of "ink" for each letter you write. Put away the paper containing your message.



When the "ink" dries, your message will be invisible. To read the message, move the paper back and forth in front of a lit lightbulb. When the paper gets warm, you should be able to read it.

The darkening of the message is due to a chemical change in the lemon juice. Do you think that heat plays an important part in chemical reactions? Try milk as an invisible ink.



Lemon Soda?

Make a small glass of lemonade for yourself. (Lemonade = water + lemon juice + sugar.) Add ½ teaspoon of baking soda to the lemonade and stir it. Do you think a chemical reaction took place? What do you think is in the bubbles?

Apple Does a Slow Burn

Oxidation is the name that chemists give the process by which oxygen combines with a material. Fire is an example of very rapid oxidation.

Cut an apple in wedges and leave them exposed to the air for a day. Check the apple wedges every few hours. What do you observe?

Take another apple wedge and soak it in a half cup of lemon juice for an hour. Leave this second apple wedge exposed to the air. What do you observe?

The lemon juice has a chemical in it that slows down the oxidation of the apple. Do you think the rate of oxidation is affected by temperature? How could you find out if the temperature of a material has anything to do with oxidation?

PUZZLING POWDERS

This is your chance to do a lot of experimenting to see the way different powders react. The experiments will give you at least an hour or two of science fun. This is an activity that should *not* be done with or near small children, since you will be using a lighted candle, a weak solution of iodine, and a few other things that should not be around the very young.

MATERIALS

powders:
granulated sugar
powdered sugar
table salt
cornstarch
powdered milk
plaster of Paris
testing solutions:
white vinegar
tincture of iodine
water
other materials:
hand lens (magnifying glass)
paper cups
aluminum foil
plastic spoons
sheet of black construction paper
toothpicks
thumbtack
candle
cardboard
clamp-type clothespin
nine plastic spoons or medicine droppers
three baby food jars
masking tape

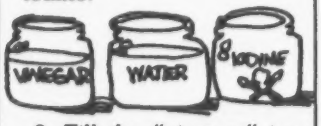
Use this chart to keep track of what you observe when you test each powder.

PREPARING YOUR EQUIPMENT

Before you start the experiments, be sure to get all your equipment and materials organized.

Testing Solutions

1. Put a piece of masking tape on each of the three baby food jars.
2. Label the jars "vinegar," "water," and "iodine."



3. Fill the "vinegar" jar one-quarter full with vinegar.
4. Fill the "water" jar one-quarter full with water.
5. Put one drop of tincture of iodine in the "iodine" jar and then add twenty drops of water. *Iodine is a poison. Be sure to put the bottle that the iodine came in out of the reach of small children. If you get iodine on your hands, be sure to wash it off.*
6. Put a plastic spoon or medicine dropper in each jar.

The Powders

1. Label six of the paper cups with the names of the powders you have. If you can't get all six powders, don't worry about it! (If you are a teacher, label the powders by number so they remain a mystery all through the experiment.)
2. Using a different spoon for each powder, put about 5 spoonfuls of each powder in the cup that is labeled with its name. Leave the spoons in the cups.

Heat Testing

1. *The heat source.*

The source of heat for the experiments will be a candle. To heat safely you need to make a stand for the candle.

a. Wrap a square of cardboard that is at least 20 cm (about 8 inches) on edge with aluminum foil.

b. Press a thumbtack up through the center of the cardboard.

c. Cut a circle in the foil around the point of the thumbtack the size of the base of the candle.

d. Light the candle and drip the wax around the point of the thumbtack. While the wax is hot, press the base of the candle on the point of the thumbtack so that the hot wax and the point of the thumbtack hold the candle firmly upright.

2. *The holder.*

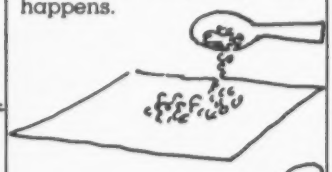
Make six aluminum foil bowls that are each 9 cm (about 3 inches) across and 2½ cm (about 1 inch) deep.

The clamp-type clothespin will be the handle for the bowls.

DOING THE EXPERIMENT

Do the following tests for each of the powders and record what you observe on the chart.

1. Hand lens: Sprinkle a little powder on the black construction paper. Look at it through the hand lens. What does each powder look like? Describe the size and shape of the powder particles, and write your description on the chart.
2. Water: Put a teaspoon of powder on a small piece of foil. Add a few drops of water. Stir the mixture with a toothpick. Record on your chart anything that happens.



3. Vinegar: Put a teaspoon of powder on a small piece of foil and add a few drops of vinegar. Stir the mixture with a clean toothpick. Do any of the powders fizz when you add vinegar? Note those powders that fizz on your chart.
4. Iodine: Put a teaspoon of powder on a small piece of foil and add a few drops of iodine. Stir the mixture with a clean toothpick. Look for a color change. Record the color on your chart.
5. Heat: Put a teaspoon of powder in one of the six foil bowls. Light the candle. Hold the bowl with the clothespin and gently move the bowl back and forth through the flame. Describe any color changes and odors that you observe.

When you are all through testing the powders, you might wish to mix a few together and then test them. After you have finished all your experimenting, be sure you do a good job cleaning up. Throw away all six powders and the solutions in the baby food jars.

PUZZLE POWDER CHART

Powder	TESTS 1. Hand Lens	2. Water	3. Vinegar	4. Iodine	5. Heat
Granulated sugar					
Powdered sugar					
Salt					
Cornstarch					
Powdered milk					
Plaster of Paris					

MARIE CURIE

The Woman Who Discovered Radium

Marie Curie (1867—1934) seemed to have a great curiosity about science as a young girl. Her father, who was a professor of physics and mathematics, encouraged her to work hard and get a good education.

Marie's knowledge of science became very important to her later in life. She and her husband Pierre worked together on experiments with the element uranium. Their work with uranium led to the discovery of a new element: radium. In 1903 Marie and Pierre Curie, along with Henri Becquerel, shared the Nobel Prize for physics.

In 1911 this marvelous scientist received a second Nobel award in yet another field — chemistry. Marie Curie was the first scientist to receive two Nobel Prizes.

1. Marie Curie once said, "Dreamers do not deserve wealth, because they do not desire it." Throughout her life she pushed aside publicity and fame. What thoughts and feelings do you have when a person like Marie Curie makes a statement such as this?

2. Marie Curie was the first woman in French history to hold a position in higher education. What is the status of women in higher education in the United States?

3. Marie Curie died in 1934. Doctors who examined her were unable to diagnose her disease. It resembled tuberculosis, but it was not. She spent her whole life working with radioactive materials. What do you think she died of?

Mary Helen Johnston, Space Scientist

Photo: courtesy of NASA

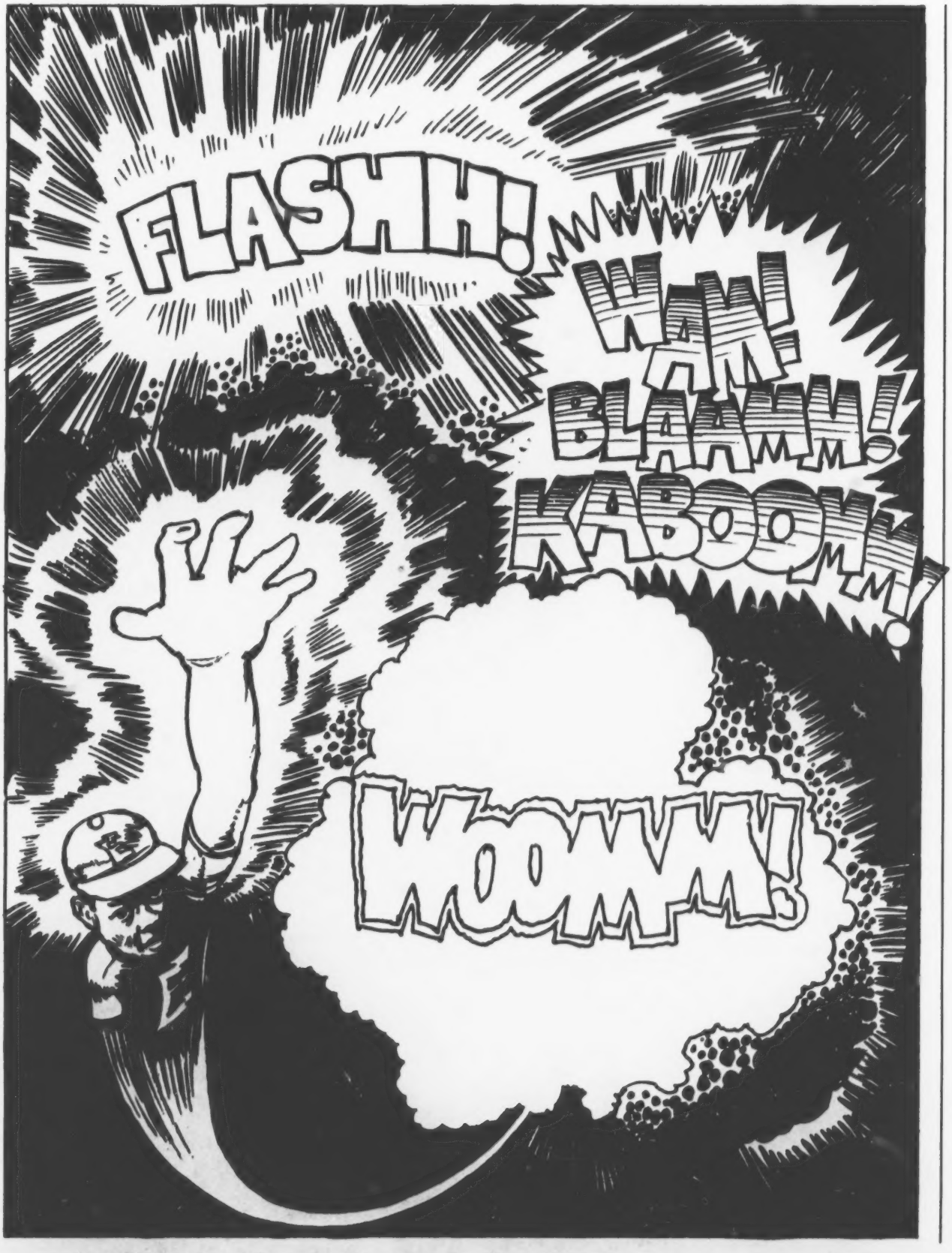
Mary Helen Johnston is employed at the Marshall Space Flight Center and is involved in the design and testing of experiments that will be used on future Space Processing Applications Rocket (SPAR) flights. As part of her work, she has done experiments aboard KC-135 aircraft and in simulated weightless conditions under water.

Dr. Johnston received her Ph.D. from the University of Florida. She has a special interest in the nature of solid materials, the growth of crystals, and the study of crystals using x-rays. In her free time, she enjoys playing tennis and practicing jujitsu.

1. Why do you think space scientists try out their experiments in aircraft or under water before they try them in space?

2. What kind of information about crystals could you get from studying x-ray "pictures" of them?

3. Does either of Dr. Johnston's free-time activities seem surprising to you? Do you think scientists use their free time much differently than people who do other types of work?


FLASHH!
WAM!
BLAAMM!
KABOOM!
WOOMM!

CHAPTER 10

ENERGIES: LIGHT, SOUND, AND HEAT

Slowly the orange bright sun appears to make its path down and away
. . . and the day sounds fade
. . . and the night sounds begin
. . . and where there was warmth there is now a cooling down.

Slowly the hours of the night pass and then just above that eastern hill
. . . a new day's light
. . . a new day's warmth
. . . a new day's sound begins to fill the air.

DARK SHADOWS

Use a filmstrip (or slide) projector or a lamp with a 100 watt bulb to give you enough light to make some of these shadows. A large piece of heavy white paper or thin cardboard will make a good screen.

Here are some things to think about or do when you are making shadows:

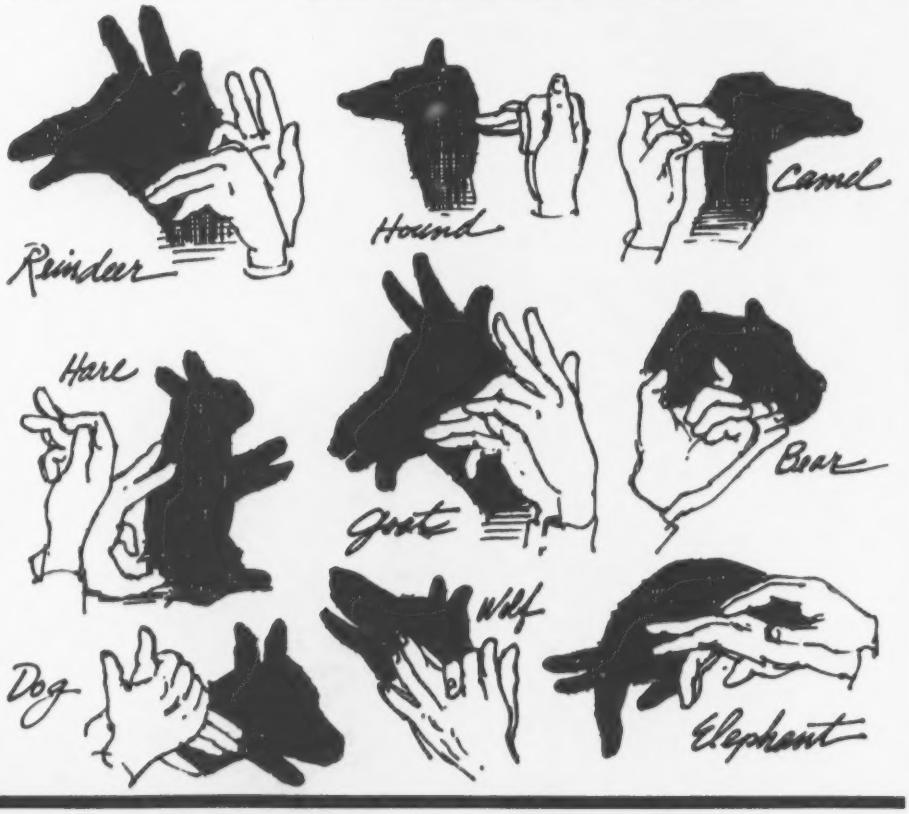
1) Where is the darkest part of the shadows?

2) What does moving your hands closer to or further from the light do to the size of the shadows?

3) What does moving the screen do to the size of the shadows?

4) Have a friend take pictures of your shadows.

5) Make some monster shadows.



Weird Periscope

Materials

five empty 1 quart milk containers
masking tape
four pocket mirrors

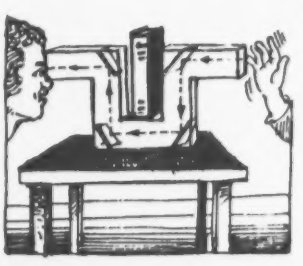
Directions

1. Cut off both ends of each container.

2. Assemble the milk containers so that you have a tube that is **hollow,** open at each end, like in the drawing. You will have to cut each tube in different places and tape the sections of this weird periscope together.

3. Put the four mirrors in place and tape them so they won't come loose. The mirrors should make a 45 degree angle with the sides of the containers.

4. Have someone wave a hand in front of one end of the weird periscope. Can you see it? This will work best in a well-lighted room. Design and try out some other strange-looking periscopes.



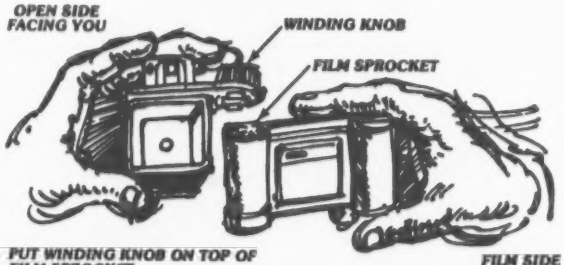
BUILD YOUR OWN CAMERA KIT

For less than two dollars you can build a camera that will take black-and-white and color prints, as well as color slides. The camera is simple to use, as you can see here.

The camera comes in a kit that you can have fun putting together. Write to:
Visual Motivations Company
Division of KFL, Inc.
Regal Road
King of Prussia, PA 19406

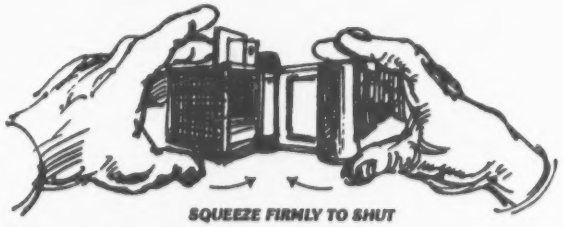
Ask for: Snapshooter "Kameras for Kids," one "Kamera" and one roll of Kodak Verichrome film for $2.00 (minimum order: $10.00 — price may be subject to change without notice).

LOADING INSTRUCTIONS FOR THE SNAPSHOOTER CLUB CAMERA



1. PUT WINDING KNOB ON TOP OF FILM SPROCKET

FILM SIDE FACING YOU



SQUEEZE FIRMLY TO SHUT

2. WHEN WINDING KNOB IS IN FILM SPROCKET, CLOSE TWO PIECES TOGETHER FIRMLY

1. TURN WINDING KNOB SLOWLY SO THAT FILM WILL ADVANCE.
2. WHEN FILM HAS MOVED INTO PICTURE TAKING POSITION, A CLICK WILL BE HEARD.
3. ADVANCE FILM FOR EACH PICTURE SLOWLY UNTIL YOU HEAR CLICK. NEXT PICTURE IS READY FOR SNAPPING AFTER CLICK.

TO RELEASE CARTRIDGE, HOLD BODY OF CAMERA FIRMLY IN RIGHT HAND AS IN PICTURE TAKING POSITION. PLACE THUMB OF LEFT HAND ON BACK OF VIEW FINDER. GRIP CARTRIDGE WITH INDEX AND MIDDLE FINGERS OF LEFT HAND. PULL CARTRIDGE WITH FINGERS WHILE PUSHING VIEW FINDER.

"WE SHOOT PICTURES NOT PEOPLE"

PHOTOGRAPHY BOOKS

Photo Fun — An Idea Book for Shutterbugs by David Webster. New York: Franklin Watts, 1973, $4.95.

Photography — How It Works, Rochester, N.Y.: Eastman Kodak Co., $.10.

Understanding Photography by George Sullivan. Warne, $4.50.

HOW TO MAKE A CAMERA

The best way to learn about cameras is to make your own, from scratch. Well, maybe not completely! Gather the following materials together:

needle
black-and-white 126 film cartridge
black adhesive tape
piece of black cardboard 3.2 cm × 14.7 cm (1¼ inch × 5¾ inch)
piece of black cardboard 3.8 cm × 7 cm (1½ inch × 2¾ inch)
piece of black paper 2.5 cm square (1 inch square)
piece of aluminum foil 2.5 cm square (1 inch square)
two rubber bands

Directions for Making the Camera

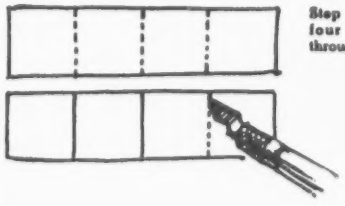
Now follow the directions below and you will be ready to click and print. Start at the beginning and when you get to the end your camera will be built.

Using the Camera

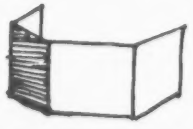
Winding the film will require a small coin or a piece of wood that you should insert in the round opening of the cartridge. Wind the film until the first number is showing.

When you take a picture, you simply lift the black tape covering the pin hole. You must do this holding the camera perfectly still. Cover the pin hole and then wind the film for your next picture.

Your camera may not look fancy or expensive, but it will take pictures.

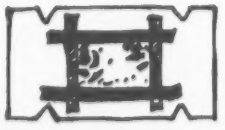


Step 1. Mark the large cardboard into four equal sections. Carefully cut through the first layer of the cardboard.

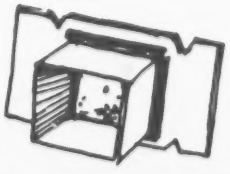


Step 2. Fold the cardboard into a box and tape edges with black tape.

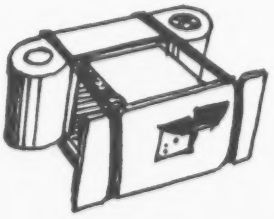
Step 3. Make a very tiny hole in the aluminum foil with the point of a needle.



Step 4. Cut a square (2.5 cm) in the small piece of cardboard. Tape the foil over this opening.



Step 5. Tape this piece of cardboard to the box you have made. Block all light by placing black tape around *all* edges.



Step 6. Attach the film cartridge to the box with two rubber bands. Place a small piece of black tape over the hole in the aluminum foil.

EXPLORING THE ENVIRONMENT WITH A CAMERA

Cameras are marvelous tools for exploring the environment. Someone once said that a picture is worth a thousand words.

For the following collection of activities you'll need a camera and a few assorted things such as a collection of old photographs, drawing paper, pens, and crayons. These activities will give you good practice using your camera. It doesn't matter whether you have a Polaroid camera, a fancy 35mm camera, or just an Instamatic.

POWER

The Action:
Go outside and find things that represent power. Sketch, photograph, or in some other way visually describe these things. Exchange power descriptions and discuss what kind of power you see in each other's descriptions.

More:
What is power?
How do you get it?
How do you keep it?
How do you lose it?
How do you use it?
Who has it?

Answer these questions by writing a poem or a play.

Measure the amount of power described.

Compare different kinds of power. Which power is most powerful? Least? Why?

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SECRET PICTURE

The Action:
Organize into teams. Each team takes a picture at some time during a week-long period. Each team should keep the time secret from the other teams, but each picture should contain a clue as to when it was taken. At the end of the week, put all of your opponents' pictures in chronological order.

More:
Do this again over long enough periods of time that clues as to changes in the environment could be recorded for each month, semester, or even year.

Do the same thing but write descriptions of the events; make a play at the end of the week.

Do the same thing but represent the events in some art forms; make a composite at the end of the week.

PATH FINDER

The Action:
Take a series of photographs along a particular route and ask someone else to trace out the route you took.

More:
Have a specific object at the last station of the route to be collected and returned (a buried rock, coin, beads).

Create a word map of a route, ask someone else to follow it.

Draw the route taken and the clues used.

What makes something a treasure? What kinds of things are treasures? Are they treasures for everyone?

FAKE A PICTURE

The Action:
Fake a picture that appears to be positive proof that something natural happened.

More:
The high point of the assignment might be a discussion of what constitutes "natural." Is man a part of nature? If so, is the assignment valid?

Is art fake? Is acting fake? Is lying faking?

Make something false appear to be proven true.

Fake a conversation between two people that's real enough so they can be identified.

Create some fake art; create some art that isn't fake.

WHO DONE IT

The Action:
Take a series of pictures that tell a mystery story. Make sure the pictures contain clues about how the story turns out.

More:
Collect clues to a natural mystery story; to a scientific mystery.

Solve a natural mystery and gather your evidence on photographs.

Repeat this exercise using sounds, smells, and tastes instead of photos.

Create a mysterious piece of art.

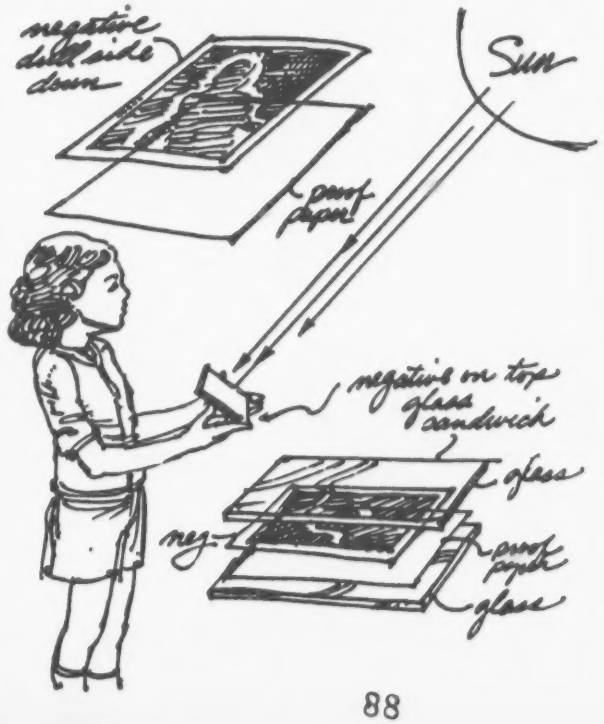
SUNLIGHT PICTURES

For this activity, you will need the following:
photographic proof paper from a photography shop
photo negatives (thin pieces of developed film that are returned with snapshots)
two small pieces of clean glass

Protect the photographic proof paper from the light until you are ready to use it. Trim the proof paper so that it is a little larger than the negative. Place the negative dull side down on the proof paper. Place it between the two pieces of glass to form a sandwich.

Hold the sandwich with the negative toward the sun until the edge of the paper changes color. You can also expose the film under a fluorescent light.

Do this again with another negative and another piece of proof paper. Place one of the pictures in a drawer and the other out in the open. Examine both pictures again in three days. Why do you suppose the picture in the drawer lasts longer? Why do you think the pictures developed in the sunlight disappear?



INVISIBLE

The Action:
Make a list of ten things in the environment that can't be photographed, then photograph any three of them.

More:
Make a collection of objects/happenings that are visible evidence for invisible forces or conditions.

Represent one of the things using any medium besides photography.

Describe one of the things without naming it.

Measure the amount of one of the things photographed.

Do invisible things ever become visible?

Map one of the things photographed.

MY PLOT

The Action:
Use some of the equipment listed here and discover as much as you can about an area in the immediate school environment. A wide variety of tools could include some or all of the following:

string
sticks
paper
camera
film
pencils
pens
tape recorders
counters

More:
Choose one of the things that you discovered and see how it changes through the year.

Describe your discoveries poetically.

Make a model of your plot that represents your feelings about it.

DOUBLE EXPOSURE

The Action:
Take a double exposure photo that portrays some change.

More:
Draw, paint, construct, or write a "double exposure" so that it portrays some change.

Determine which exposure was taken first.

Tell a story with double exposures.

Try half-frame photos (very difficult), with a card held over one-half of the lens, and then over the other half.

Portray a social change or a natural change with your double exposure.

Show people or things in different moods, shapes, and so on; use any medium.

YESTERDAY, TODAY, TOMORROW

The Action:
Using photographs taken in earlier assignments or pictures from magazines, study prints, and so on, determine how the area in the picture will look some time in the future and how it looked some time in the past.

Materials for this would be:

the pictures
frosted acetate or tracing paper
tape
pencils (regular or colored), pens, or grease pencils

Fasten the acetate or tracing paper over the photograph and indicate the way the area looked in the past or will look in the future.

More:
Try using photographs of environments of varying degrees of abstraction such as:

places far away
places that show no evidence of man
the moon
places near home
places inside your house

Write a story about the area yesterday, today, tomorrow.

Represent, using any medium, the life style of the area yesterday, today, and tomorrow.

CAMERA PROJECTS

1. Art Show.
Use your own camera or borrow one to take some photographs of scenes and people. Select your best pictures, showing a variety of your work. These pictures should show correct exposure, good focus, and an interesting arrangement of people and things. If one or two of the pictures are outstanding, you might wish to have them enlarged. Use your pictures to put on an art show of your work.

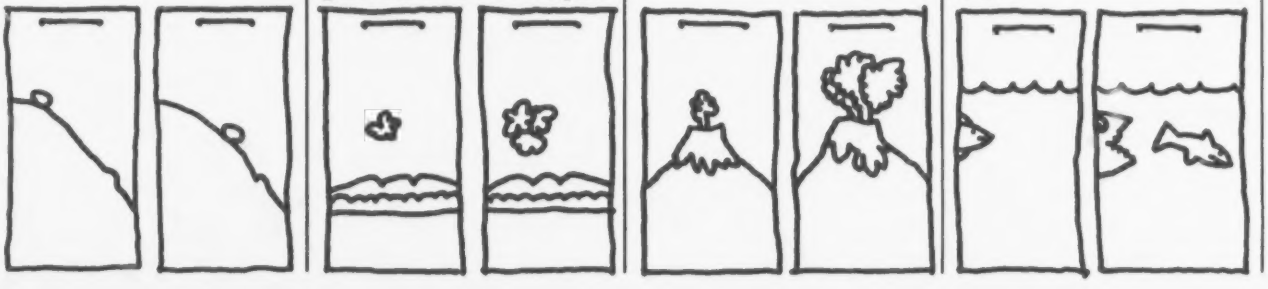
2. Amateur Photographs.
Collect a bunch of photographs taken by amateurs like your mom, dad, or teacher. Choose about a half dozen and look them over. For each photo, look at both the good and the poor features of exposure, focus, and composition. Display the photos and jot down their strong and weak points.

3. Special Techniques.
So you're pretty good with a camera! Choose a type of photography that requires a special technique, such as flash, indoor, nighttime, or underwater photography. Get books from the library or a camera store and read about your topic. Then write or orally deliver a brief report that could help others improve their photography. Describe how to go about taking the pictures and any special problems to watch out for.

HOW TO MAKE FLIP BOOKS

A flip book is a neat way to begin to understand motion pictures. It can also be used to find out about a variety of things. This activity is designed to help you to make flip books. Try making simple ones at first, then graduate to more complex flip books. Here are a few ideas to get you started. Select any pair of these frames and complete a flip book for it.

You'll need to cut out about twenty-five pieces of paper approximately 8 cm × 8 cm.



TAKING PICTURES...SOME TIPS

SSSTTTOP SHAKING THE CAMERA. I JUST HAD MY BREAKFAST. HOLD THE CAMERA AGAINST YOUR CHEEK AND PUSH DOWN THE SHUTTER GENTLY.
HEY, YOU CUT OFF MY HEAD! LOOK THROUGH THE VIEWFINDER AS YOU AIM YOUR CAMERA.
WHOA!!!.....STOP WINDING WHEN YOU HEAR THE CAMERA CLICK. THIS WILL HAPPEN WHEN YOU GO PAST THE CLICK.
MY, YOU LOOK A LITTLE FOGGY. GUESS THE CARTRIDGE WAS LOOSE.
MAKE SURE BACK FITS TIGHT SO LIGHT CAN'T LEAK IN.
IS THAT MY GHOST? NO, IT'S MY DOUBLE. YOU FORGOT TO WIND THE FILM FORWARD. REMEMBER, SNAP... WIND... AND LISTEN FOR A CLICK SOUND.
WHAT HAPPENED TO THE LIGHTS? WITHOUT SUNSHINE I'M ONLY A SHADOW.
DON'T SHOOT IN DARK AREAS.... OUTDOORS AND NEVER INDOORS.
HEY, I'M THE INVISIBLE MAN! YOU DIDN'T WIND MY FILM UP AFTER THE LAST SHOT. I WAS EXPOSED TO THE SUN AND DISAPPEARED WHEN YOU TOOK THE FILM OUT.
YOU AND YOUR BIG THUMB! BE CAREFUL TO KEEP YOUR HAIR, FINGERS, CLOTHING AND CAMERA STRAP AWAY FROM MY LENSE.
PRACTICE... PRACTICE... PRACTICE: ① HOLD THE CAMERA SNUG AGAINST YOUR CHEEK, ② TAKE A DEEP BREATH AND HOLD IT WHILE YOU ③ GENTLY PUSH DOWN THE SHUTTER RELEASE WITHOUT SHAKING THE CAMERA. ALWAYS PRACTICE BEFORE LOADING CAMERA

Based on "Snapshooter says: 'Avoid these mistakes.'" Courtesy Visual Motivations Company.

SOUNDS OF MUSIC:

Nine Instruments You Can Make

Here are the instructions for nine instruments you can make with easy-to-get materials and simple tools.

EAR HARP

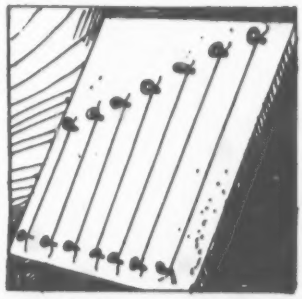
Materials

38 cm length of board (pine or other soft wood) about 2 cm × 30 cm (sold as 1 inch x 12 inches in lumberyards); if possible, get "select" pine, which has no knots in it
nylon fishline (squidding line is best)
six or eight nails about 3.8 cm (1-1/2 inches) long with heads
six or eight screw eyes (size #112) and a large nail
hammer saw
ruler sandpaper

Directions

1. Draw a line near and parallel to one edge of the board. Then draw a slanting line from an opposite corner. Hammer an evenly spaced row of nails partway into the board along one of the lines, one nail for each string.

2. Using the large nail to start the hole, insert a screw eye partway into the board along the other line opposite the first nail. Then attach a piece of fishline to the nail with a good firm knot. Pull the string fairly tight and tie it securely to the screw eye. You can make the strings tighter by turning the screw eyes. (Screw eyes are easier to turn if you use a nail through the eye as a lever.)



3. Do the same for the other strings. After all of the strings are connected, tune them as you like by tightening or loosening them.

If you hold the back of the harp against your ear while you play it, the sound will seem richer and warmer to you. Also, some ear harps sound stronger if you prop them up on a table with a block of wood under one corner. If you want your harp to sound much louder, hook up a microphone to the loudspeaker system of a tape recorder or a phonograph and put the microphone on the board while you pluck the strings. Try this with other instruments, too.

Excerpted with some revision from Musical Instruments Recipe Book, Webster Division, McGraw-Hill Book Co. Copyright© 1968, 1971 Education Development Center, Inc. Used with permission. No endorsement given.

ONE-STRING STICK GUITAR

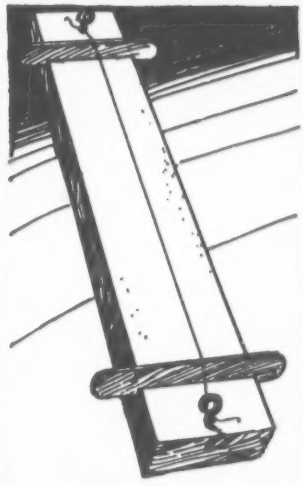
Here is a one-string version of the ear harp. You can play different notes by pressing the string against the wood in different places while you pluck it.

Materials

60 cm length of wood about 4.3 cm x 2 cm (sold as 1 inch x 2 inches at lumberyards)
1 m of nylon fishline (squidding line is best)
two Popsicle sticks or wooden coffee stirrers
two screw eyes (size #112) and a large nail
saw hammer

Directions

1. Insert a screw eye near each end of the wood strip.

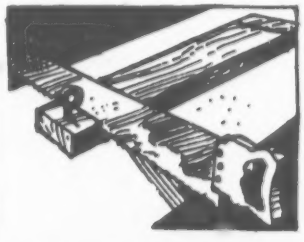


2. Saw a shallow groove across the strip about 4 cm from each end.

3. Insert the Popsicle sticks sideways into the grooves, and tie the string between the two screw eyes.

4. Using the large nail as a lever, tighten the string by turning one of the screw eyes.

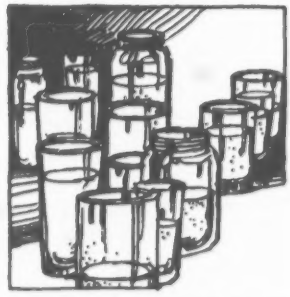
The one-string guitar will sound louder if it rests on top of a wooden table or a large hollow container, and it will also sound much louder to you if you hold the back of the strip against your ear while you play.



WATER BELLS

Water bells are easy to make. You'll need a supply of water and some drinking glasses or other glass containers that respond with clear ringing sounds when you strike them. Wooden pencils or dowels make good strikers.

Adding water to the containers will change the pitch of the sounds. To get a good range of pitches you will probably need more than one size container, since the difference in pitch between a full container and an empty one of the same size is often no more than a few notes.



Water bells are excellent instruments to use for experimenting with pitch changes — and for playing tunes and making up songs, too.

WIND CHIMES

Wind chimes can be made from many materials, such as:
various kinds of nails
scraps of metal
pieces of glass or plastic (colored glass is beautiful moving in the sunshine)
strips of wood
dowels
pieces of bamboo
short pieces of aluminum tubing and aluminum angle (both .8 cm diameter tubing and 1.75 cm diameter angle make a strong, clear ringing sound)
Hang the pieces of mate-

rial you choose so that they will strike one another when they move.

Suspend them from a straight bar or, for more collisions, hang them from a small triangular frame made by nailing three pieces of wood together. They may also be suspended from a circular band made from metal stripping, a small cheese-box lid, an embroidery hoop, or any small piece of pegboard, heavy cardboard, or metal sheeting.

For a variety of sounds, use pieces of several different sizes (the exact dimensions aren't important).

Wooden Chimes

Bars of wood struck with a hard object and allowed to vibrate freely make sounds of definite pitch. As a rule, the longer the piece of wood, the lower the sound it makes. Any group of random lengths will give you a variety of sounds. (See below for ways to suspend the bars.) With a bit more effort, it is possible to make a tuned set. Here are directions for making a set with which you can play an A major scale.

Materials

4 m length of wood, 2 cm x 4.3 cm (sold in lumberyards as 1 inch x 2 inch); soft woods such as clear pine are inexpensive and are easy to work with (avoid knotty pine — the knots almost invariably deaden the tone)

2 m of heavy twine (sisal or baling twine works well)

piece of doweling or other wooden stick for a striker

screw eyes or staples

saw

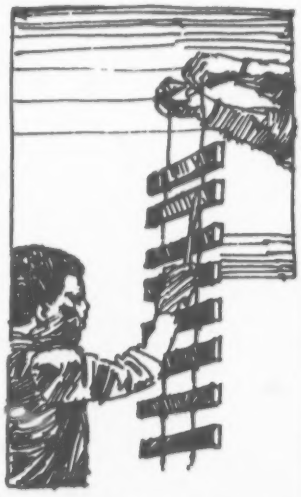
hammer or stapler

Measure the wood carefully before you cut it into bars, one each of these lengths:

50.8 cm	41.7 cm
48.3 cm	39.1 cm
45.0 cm	36.6 cm
44.2 cm	34.1 cm

Tuning

The set of bars will need some fine adjustments to play a proper scale. Here are some suggestions. A convenient way to arrange the bars for comparing the sounds they make is to lay all of them out in order from shortest to longest on a piece of rope or twine. The vibration pattern in a wooden bar is such that there is a node point, or "dead spot," about one-quarter of the way in from each end of the bar. If you arrange the bars so that they touch the twine only at these two points, they will be able to vibrate freely and produce a clear tone. (If the twine or the table top or your fingers touch other places on a bar, the sound may be deadened.)



Start with the longest (50.8 cm) bar as the lowest note, do, and tune the other pieces in order. Tune the 48.3 cm piece so that the first two pieces play do-re. Then add the 45 cm piece and adjust it so that all three pieces sound out do-re-mi. Continue with each piece until the whole scale is in tune.

To make the sound of a bar a little higher, saw a bit off one end. To make the sound lower, saw a little way into the bar, perpendicular to the length, in the middle of the bar. In both cases, a little cutting can make a lot of difference in the sound, so go easy.

Some Further Notes on Tuning

Tune in a quiet place.

Take your time. If you find it hard at first to hear pitch relationships between the bars, keep playing them until their sound is quite familiar to you. Most people's ability to hear pitch differences improves dramatically after they work with an instrument for a time.

If you can't manage the tuning alone, ask someone to help you.

Two Ways to Finish Your Instrument

If you want your instrument to resemble a xylophone, complete it this way: Make a long upside-down U shape out of the piece of twine. Arrange the bars on top of the twine in order: shortest bar at the curve of the U and longest bar nearest the open end of the U. Insert each bar between the strands of the twine by untwisting the twine just enough to push the bar ends through. The strands of twine should encircle the bars about one-quarter of the way in on each side (at the node points). When all the pieces are in place, the twine can be stapled to the bars of wood.

Tie a knot in the ends of the twine to prevent it from unraveling. The instrument can be laid flat on a table to be played, or it can be carried about or hung from a support and played in a vertical position. Wooden drumsticks, dowels, or mallets (made by glueing a thread spool to the end of a stick) make good strikers.

If you wish to hang the bars like chimes, insert a screw eye in the end of each bar and thread a length of string through the eye to make a loop. Suspend the bars from a broom handle, a wooden bar, or a classroom map frame.

Sand Blocks

The rubbing together of blocks of wood covered with sandpaper can give an interesting background rhythm to music played with simple instruments. Here are instructions for making sand blocks so that you can give music a very different kind of beat.

Materials

two small blocks of pine or other soft wood about 2.54 cm × 10.2 cm × 12.7 cm (the exact size is not important)

sandpaper or emery paper

thumbtacks

thread spools and glue, or knobs and screws

Directions

1. Cover one surface of each block with sandpaper.

2. Bring the sandpaper over the sides of the block and fasten it on with thumbtacks.

3. For handles, glue an old thread spool to the plain side of each block or buy knobs at a hardware store and attach them with screws.

Different grades of sandpaper and emery paper will make different sounds. You can test the sound by rubbing two bits of the paper together before you tack it to the wood. Make more than one kind of block for a variety of sounds!

Garden Hose Recorder

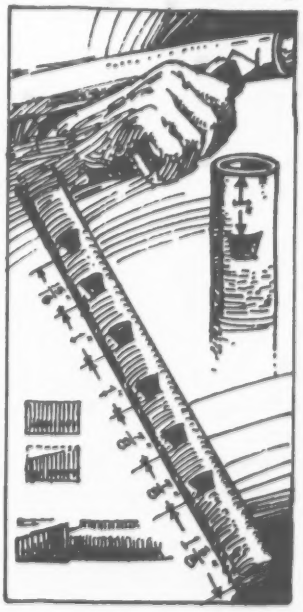
Materials

piece of plastic garden hose about 12 inches long (transparent green hose with 1/8 inch wall works well)
1 inch piece of dowel wide enough to fit snugly inside hose
mat knife or utility knife
12 inch piece of dowel that fits loosely into hose
coarse sandpaper

Directions

1. Cut an air hole, like the one below, 1 inch from the end of the piece of hose. (You may want to trace the pattern and mark it on your hose.) It's much easier to cut the hose if you put the long loose-fitting dowel into the hose for a brace.

2. With the sandpaper flat on the table, sand the 1 inch dowel until you have a smooth, flat, slanting surface along one side.



3. When you have sanded the plug, put it into the end of the recorder so that the sanded surface slants up to the air hole as shown.

4. If you are very lucky, you will blow a clear note right away. If the recorder doesn't play well at first, try moving the plug backward or forward a little in the tube. If it is hard to blow, the plug probably needs more sanding. If there is a large air passage but the recorder still doesn't play, you may need to make the slant of the plug steeper. If you have sanded the plug too much, you may need to get another piece of dowel and start over. However, don't start over until you have tried everything else.

5. When your recorder will play one note nicely, you may want to make note holes. First, just try blowing your recorder very softly, then harder and harder. See how many notes you can get simply by blowing in different ways. Then insert the long, loose-fitting dowel into the hose again at the end opposite the mouthpiece. With your utility knife, make a .8 cm square hole about 4.2 cm from the end of the hose. Play the recorder while you cover and uncover the hole. Then add as many holes as you like, spacing them as shown here. With each new hole, play the recorder to see how it sounds.

A Recorder Tuned to the Major Scale

To make a recorder that will play a scale involves precise work. Use a piece of hose exactly 12⅝ inches long with a ½ inch inside diameter. Make all the note holes ¼ inch square and place them as shown in the drawing.

Don't be discouraged if your first attempt isn't perfect. This is a hard instrument to make, and you may have to make more than one to get a recorder that will play in tune.

Playing Notes

To play the first note of the scale, cover all the holes and blow softly. For the next six notes, remove one finger at a time, starting from the lower end of the tube. To get the highest note of the scale, replace all your fingers on the holes, and blow a little harder than you did before.

Variations

Any kind of fairly stiff tubing can be used to make a recorder. Simply make sure that you have a dowel for the mouthpiece that fits snugly into the tube. Use the pattern for the garden hose recorder as a model for your air hole, making adjustments for differences in diameter (wider hose, bigger air hole). It's best to make the air hole a little bit on the small side and then enlarge it if necessary.

A length of hula hoop will make a simple flute. Cut a piece about 12 inches long and make a shallow hole about 1 inch wide, about 1 inch from one end. Plug the end near the hole with a cork or a piece of dowel. Blow across the edge of the hole as you would blow on a soda bottle.

Wood-Block Tambourine

Materials

15.2 cm block of wood, about 2 cm × 4.2 cm (called 1 inch × 2 inch at lumberyards)
bottle caps
nails with wide heads
hammer
sandpaper (to smooth rough edges)

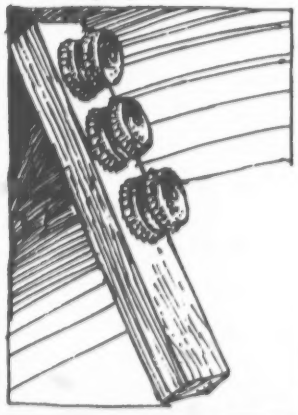
Directions

1. Remove the cork from the bottle caps.

2. Hammer a nail through the bottle caps partway into the wood block. Make sure that the hole in the bottle cap is wide enough for the cap to slide freely along the nail.

3. Use as many nails and as many caps on each nail as you like.

4. Shake the tambourine or slap the wooden side against your hand or knee to play it.



Tongue-Depressor Finger Piano

Here's one type of "thumb piano" that is quite easy to make.

Materials

six or more tongue depressors
block of wood about 20.3 cm long
2 C clamps (about 10 cm size)

Directions

1. Arrange the tongue depressors across the edge of a table, so that each one sticks out to a different length.

2. Put the block of wood over the tongue depressors, and fasten it to the table with C clamps.

3. Tighten the clamps until there is no rattle or buzz when the "piano" is played.

4. To change the sounds, loosen the clamps and alter the overhanging lengths.

You can make portable finger pianos, too.

Materials

half-gallon cardboard paint bucket
Elmer's Glue-All
five tongue depressors
seven or eight Popsicle sticks
single-edge razor blade or utility knife

Directions

1. This piano uses an upside down paint bucket, with a little hole cut in it, as a resonator and support.

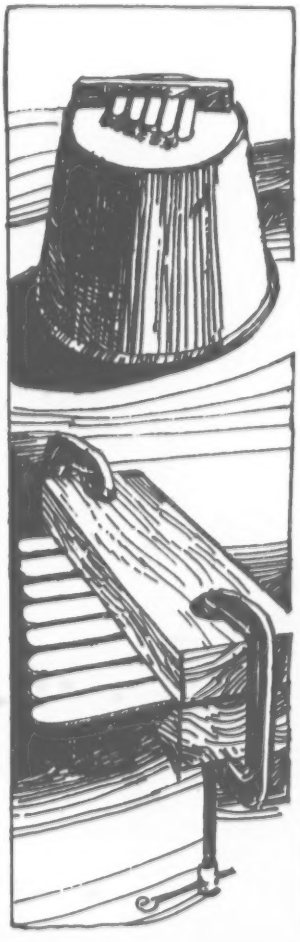
Cut one of the tongue depressors to fit across the bucket, just touching the inside rim. You can cut it with a knife or razor blade or score it top and bottom so that it will break off clean.

2. Use this tongue depressor to mark the other four for cutting. Then line up five Popsicle sticks so that they stick out different lengths and cut off the other ends even.

3. Now make a sandwich by glueing together three of the cut tongue depressors, then the cut ends of the Popsicle sticks glued in at right angles, then the other two tongue depressors.

4. Glue two halves of a Popsicle stick on top of each other and under the finger edge of the piano to prop it up.

5. Glue the piano in place against the rim of the bucket, tape it to the sides to hold it firm, and let it dry overnight before you play it.



BOOKS ON SIMPLE INSTRUMENTS

Each of the following books by Larry Kettelkamp (William Morrow & Company, New York) contains suggestions for making simple instruments and information about the history and construction of a family of traditional instruments. Each book is clearly and simply written and well illustrated.

Flutes, Whistles, and Reeds (1962) is an account of the development of woodwind instruments. There are instructions for making simple instruments, such as the elderberry whistle and the shepherd's pipe, and illustrated descriptions of some of the sound-producing mechanisms in more complex woodwind instruments.

Drums, Rattles, and Bells (1960) tells about the history and musical use of many kinds of percussion instruments from different parts of the world. Illustrated instructions for making drums, a xylophone, and water-glass bells are included.

Horns (1964) is a brief history of brass instruments, with information about how ancient and modern instruments were and are made and played. This attractive book also contains suggestions for experimenting with shower hoses, water pipes, and the like, as well as a detailed description of the process by which a modern French horn is made.

Singing Strings (1958) deals with the violin, guitar, and keyboard families of stringed instruments, in similar fashion.

OTHER MUSIC BOOKS

Indian Music Makers, by Robert Hofsinde (New York: Morrow, 1967), gives an interesting account of musical instruments and singing in the life of American Indian tribes. The author includes descriptions of how several Indian musical instruments were constructed, in enough detail for readers to make them.

Musical Instruments of Africa, by Betty Warner Deitz and Michael Babatunde Olatunji (New York: John Day, 1965), contains pictures and descriptions of many unusual instruments that you may want to try to make.

Making and Playing Classroom Instruments by Marcell Vernazza (Palo Alto, Calif.: Fearon Publishers, 1959) and **Make Your Own Musical Instruments** by Muriel Mandell and Robert E. Wood (New York: Sterling, 1959) are two handbooks for making musical instruments.

Tuning Forks

A tuning fork gives out sound of a certain pitch. The highness or lowness of the sound is usually marked on the fork. To get a tuning fork to produce sound, you simply hit it with a small rubber hammer or strike it against the heel of your shoe.

1. Strike a tuning fork gently and put the prongs into some water. What happens at the surface of the water?

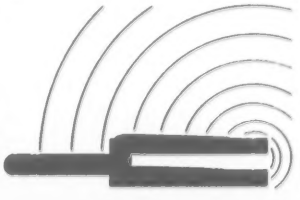
2. Hit the tuning fork again and touch the prongs to a piece of paper that you hold at one corner. What kinds of sounds are made?

3. Strike the tuning fork hard and touch the handle to a table or desk top. Now repeat this, but try holding it against different surfaces, such as a pane of glass, a metal pot, a wastepaper basket. How do the sounds compare?

4. Get a number of tuning forks that are each at a different pitch. Strike each one with a rubber hammer. Listen to the sounds. Which forks give out the nicest sound when they are struck?

5. If you play a musical instrument or know someone who does, you can find out which combination of forks will make chords.

6. Get two tuning forks that have the same pitch. Strike one very hard and hold the bottom of the handle against a table top. Now hold the handle of the second fork against the table top. After 10 seconds, lift the fork you struck from the table. Listen to the fork you didn't hit. Is it ringing? Does this experiment work better when the forks are close together or far apart?



LOW FI

The grooves in a record contain patterns that cause the phonograph needle (or stylus) to move back and forth and up and down very quickly. The amplifier and speakers that are all part of a phonograph (record player) change the vibrations from the stylus into sound waves that move through the air to our ears.

Here are two ways to get sound from a record without using the needle, amplifer, and speakers. Be sure to use an old record that nobody else wants, since these activities may damage the record.

Card Trick

Put a sewing needle through one corner of a playing card. Turn on your phonograph and place the end of the needle on the grooves of the record. Hold the card lightly. How good is the sound you are getting?

Cone Tone

Roll a sheet of construction paper into a paper cone and tape it. Now put a sewing needle through the sides of the cone at a point that is 3 cm from the narrow end.

Turn on the phonograph and place the needle end of your paper cone on a groove. Hold the cone very lightly. How is the sound? Is it better or worse than when you tried this experiment with the playing card?

Experiment with different-sized paper cones and paper of different thicknesses until you get a good sound-producing paper cone.

Try this activity with an aluminum-foil cone.

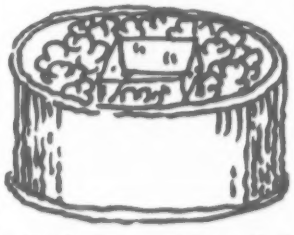
HEAT ENERGY

CUBE SAVER

Can you design a container that will keep an ice cube from melting? Actually, you won't be able to keep an ice cube from melting, but you should be able to slow down the melting process.

First you need to find out how fast an ice cube melts without a special container. This will give you a time to beat. Write this number in this space. Put an ice cube on a dish and allow it to melt completely. How many minutes does it take to change into water?

Find a plastic or metal container that is bigger than the ice cubes you are trying to save. The container should have a top.



Find some materials that you can use to keep all sides of the ice cubes away from the sides and top of the container. Here are some things you might want to use:

sawdust
aluminum foil
sand
water
cotton
newspaper
cardboard
wool
nylon
modeling clay
sponges
uncooked rice
mineral oil
small balloons
popped popcorn

Be sure to use the same size ice cubes each time you try to make a cube saver.

Experiment with as many different kinds of materials as you can. Keep track of the time it took for an ice cube to melt when it was surrounded by each material.

A material that slows down the flow of heat from one object to another (from the air to the ice cube, in this experiment) is called an insulator. What was the best insulator you used? How long did it save your ice cube?

KEEPING COOL

This is an experiment that will help you decide on the color of clothing you should wear on hot, sunny days.

Materials

lamp with a 100 watt bulb
squares of cloth of different colors, including white and black (each square should be the same size: 10 cm on a side)
square of aluminum foil 10 cm on a side
thermometers

Directions

1. Write down the temperature for each thermometer.
2. Cover each with a different colored cloth.
3. Cover one with the square of aluminum foil.
4. Arrange the covered thermometers in a circle that has a 60 cm diameter. Hold the lamp in the center of the circle.
5. Write down the temperature of each thermometer after 1, 2, 3, 4, and 5 minutes.

Which color cloth let the most heat get through?

Which color cloth let the least heat get through?

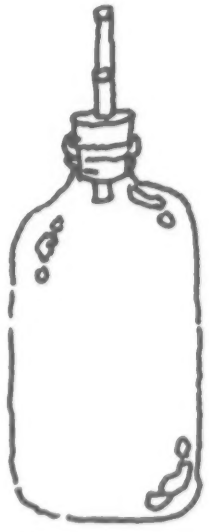
Do you think an aluminum foil shirt or blouse would be good to wear in the summertime? What problems would it cause?

WATER HOT AND WATER COLD

What happens to water when we add heat to it? What if we take heat away? Here is a way to check your ideas about the way water behaves.

Materials

blue food coloring
bottle
cork (or one-hole stopper) that fits the mouth of the bottle
bowl of ice water
bowl of hot water
marking pen
candle
hand drill
soda straw



Directions

1. If you have a one-hole stopper, put the straw through the hole so that 3 cm of straw comes through the bottom. Use hot wax from a candle to seal any space between the sides of the straw and the stopper. If you don't have a one-hole stopper, do the following:

a. Using the hand drill, make a hole through the center of the cork. Use a bit (the part of the drill that bores the hole) that is almost the same width as the drinking straw.

b. Put the straw through the hole so that 3 cm (about 1 inch) of straw will come through the bottom. Drip wax from a burning candle around the cork at the spot where the straw comes through. Do this at the top and bottom of the cork.

2. Place two or three drops of food coloring in the bottom of the bottle and then fill it to the top with water.
3. Put the stopper or cork containing the straw into the top of the bottle so that the colored water goes part of the way up the tube.
4. Mark the place on the straw where you can see the top surface of the colored water.
5. Put the bottle in the pot of ice water. What happens to the level of the water in the straw?
6. Take the bottle from the ice water and let it come back to room temperature.
7. Now put the bottle in the pot of hot water. What happens to the level of the water in the straw?

COOLING IT

Here are some projects you can do to study the ways in which heat travels. Be careful with the wooden matches and lit candle. Be sure to keep both out of the reach of young children.

Materials

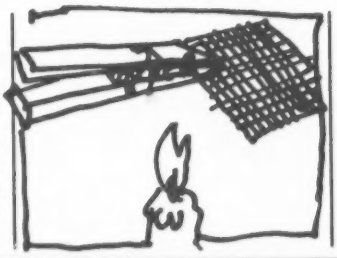
clamp-type clothespin
candle
candleholder
ten wooden matches
20 cm (about 8 inch) piece of bare thin copper wire
20 cm piece of bare thick copper wire
20 cm piece of aluminum wire
10 cm × 10 cm piece of screen

Projects

Use the clamp-type clothespin as a holder for the wire and screens for all these projects.

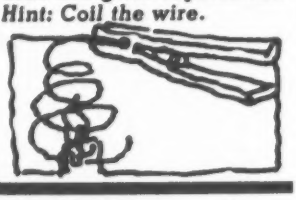
Flame-Putter-Outer #1: Which of these works best as a "flame-putter-outer": thin copper wire, thick copper wire, aluminum wire? Can you put the flame out five times in a row with the same spiral? ten times?

Flame-Putter-Outer #2: **Can you put a candle flame out just by using the thin copper wire and clothespin? No, you can't blow the flame out or touch the wick. If you can't figure this out in 15 minutes, check the hint at the end of this activity.**

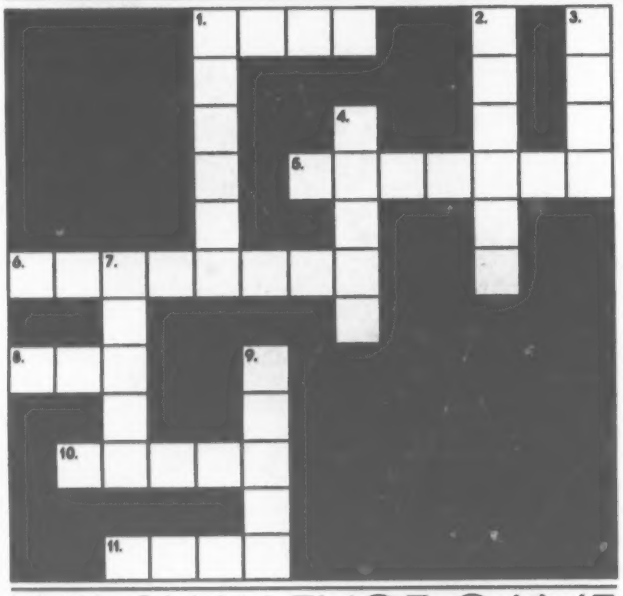


Heatscreen #1: **How does the heat travel when you heat one corner of a piece of screen with a candle flame? Can you see the path that the heat takes?**

Heatscreen #2: **Does the screen keep the flame from going through it? Does it keep the heat from going through it? Try pulling the screen out of shape and then doing the experiment.** ***Hint: Coil the wire.***



ENERGY THINKER I



THE CHALLENGE GAME

TRY THE CHALLENGE GAME FOR SOME FUN WITH PHYSICS. YOU CAN FIND IT IN THE "GAMES AND OTHER NIFTIES" SECTION.

ACROSS:

1. You need ____ to give your body energy.
5. ____ gas can be pumped to your home for heating and cooking.
6. Fuel for automobiles is called ____ .
8. The first successful ____ well was drilled in the United States in 1859.
10. The thick liquid that is pumped from underground pools is called ____ oil.
11. Nuclear energy is energy released when an ____ is split.

DOWN:

1. Coal, natural gas, and oil are called ____ fuels.
2. ____ is the power to make things move.
3. The Europeans were the first to mine ____ for heating.
4. In a steam engine coal is burned to heat ____ .
7. Energy from the sun is called ____ energy.
9. When water boils, ____ is released to work for us.

ANSWERS:

ACROSS			DOWN		
1. Food	8. Oil	6. Gasoline	1. Fossil	4. Water	9. Steam
5. Natural	10. Crude	11. Atom	2. Energy	7. Solar	
			3. Coal		

From Energy Activities with Energy Out. **Federal Energy Administration, Washington, D.C., 1976, p. 17.**

ENERGY THINKER II

1. Which popular dance step takes the most energy to do?
2. Make a frown, then smile. Which takes more energy?
3. Explain how the energy from the apple you eat can be traced back to solar energy.
4. Compare your energy sources with those of the plant world.
5. From your immediate surroundings, list things that require energy to be useful.
6. Can you store energy?
7. How can energy be measured?
8. Do moods affect your energy level? What about the weather or seasonal effects?
9. Keep a record of your energy sources and compare this to a list of your energy expenditures. Compare your records to someone else's records.
10. Does learning use or create energy? Explain.
11. Think of an experiment to demonstrate energy change.
12. What is our prime source of energy?
13. Energy has many forms. How many forms can you list, with examples?

We thank Susanne Rose for permission to use the activities for *Energy Thinker II*.

MAN

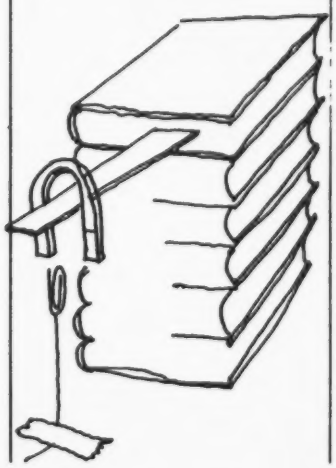
CHAPTER 11

MAGNETISM, ELECTRICITY, AND GRAVITY: SOME PUSHES AND PULLS

In this chapter you will find activities that will give you an opportunity to make magnets, build simple circuits using flashlight batteries for power, experiment with pendulums, and carry out many other activities.

AGAINST THE LAW OF GRAVITY

LOOK AT THE DRAWING BELOW AND THEN ASSEMBLE A TOWER OF BOOKS WITH RULERS STICKING OUT AT VARIOUS PLACES. PUT BAR MAGNETS ON THE RULERS. TIE THE PAPER CLIPS TO THE ENDS OF VARIOUS LENGTHS OF THREAD AND TAPE DOWN THE FREE ENDS OF THE THREAD.



MAGNETS

You probably have used a magnet to pick up a piece of metal containing iron. If the metal was light, you may have noticed that the magnet's effect could be seen before the magnet touched it. In this experiment, you'll be able to actually see the effects of magnets on the space around them.

Materials

two bar magnets
two horseshoe magnets
2 spoonfuls of iron filings
ten sheets of heavy notebook-size paper
sheet of clear acetate (same size as paper)

Directions

1. Lay the paper over any one of the magnets.
2. Sprinkle the filings over the paper so that you cover the area over all sides of the magnet.
3. Tap the paper. What do you observe?
4. Make a sketch of what you observe on the paper. Also draw a picture of the magnet that was under the paper. Be sure to label its north (N) and south (S) poles.
5. Do this with each of your magnets.
6. Try combinations of magnets.

If you are doing this in school, ask to use the overhead projector and repeat the experiment using acetate (clear plastic) instead of the paper. The magnetic fields you form will be projected on a screen. Try moving the magnets. Observe what happens.

MAKING AN ELECTROMAGNET

Materials

8 to 10 cm (3 to 4 inch) steel bolt
nut that fits the bolt
2 m (6.5 feet) of bell wire
two #6 dry-cell batteries
20 paper clips

Directions

1. Put the nut on the end of the bolt.

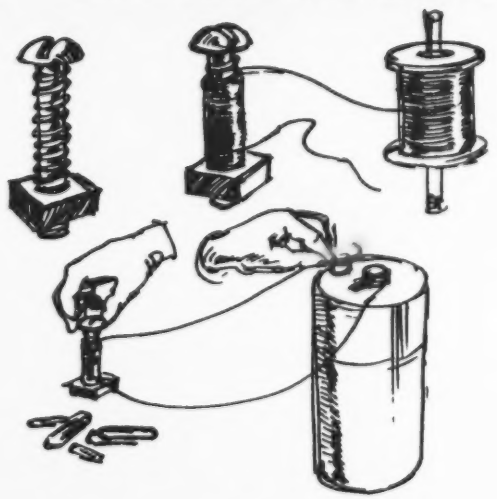
2. Begin wrapping the bell wire in a tight coil around the bolt, starting at the head of the bolt. Start at a point on the wire that is at least 30 cm from one end.

3. Keep wrapping the wire until you get to the nut. Continue to wrap up and down the bolt until it is covered with three or four layers of wire.

4. Attach an end of the wire to one of the posts at the top of the dry cell.

5. Get some paper clips and place them in a pile on the table.

6. Have a friend touch the other end of the wire to the second terminal while you hold the wrapped bolt over the paper clips. What happens? Have your friend take the wire away from the post. What happens?



7. Is there any magnetism left in the bolt after the battery is removed from the circuit?

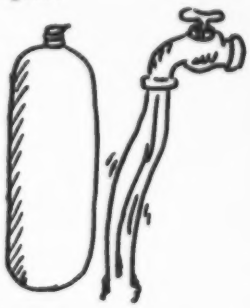
8. Have any of the paper clips become magnets?

Static Electricity

Have you ever gotten a mild shock by walking across a rug and then touching a doorknob? The build-up of electrons on your body that happened as the bottom of your shoes moved across the surface of the rug is called a *static* charge. The shock you felt was caused by these extra electrons leaving your body and entering the doorknob.

Here are some experiments you can do to explore this increase or decrease of electrons on an object. *These activities work best on a very dry day.*

The Sticking Balloon
Blow up a balloon and tie the end with a string. Briskly rub the balloon across a piece of fur or wool. Now touch the balloon to the wall. If the balloon doesn't stick to the wall, rub it again.



Water Bender Balloon
Turn a sink faucet on so that a thin, steady stream of water flows out. Now, rub a balloon with wool or fur and then bring it near the stream. What do you observe?

Two Balloons
Inflate two balloons and tie a long thread around the neck of each. Tack the end of the thread of one balloon to the top of a door jamb. Place a static charge on the hanging balloon by rubbing it with a piece of fur or wool. Do the same to the second balloon. Hold the end of the thread on the second balloon and bring it close to the hanging balloon. What happens?

The Comb and Static Electricity
A hard rubber or plastic comb is a good electron gatherer. Build a static electrical charge on a comb by rubbing it briskly with a piece of wool or fur. Now bring the comb near a thin stream of water running from the faucet. What do you observe?

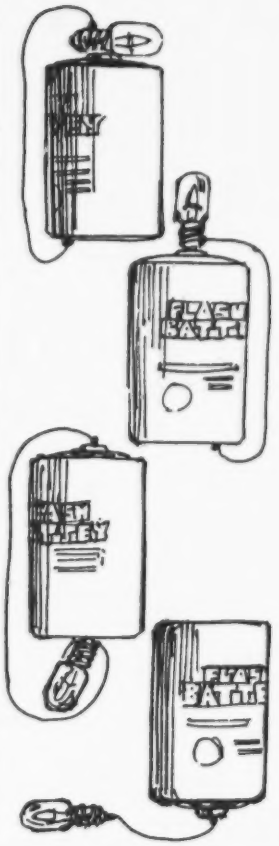
The Comb and the Ping Pong Ball
Place a ping pong ball on a level surface. Charge a hard rubber or plastic comb by rubbing it with wool or fur. Bring the comb near the ball. What happens? What would happen if you built up a charge on the ping pong ball? Would the experiment still work?

SIMPLE CIRCUITS I

The easiest and safest way to learn about electricity is to use flashlight batteries, small bulbs, and wire. No part of the experiment should be tried using any source of electricity other than D-size batteries.

Materials
D battery
two 20 cm (about 8 inch) pieces of #20 bare copper wire
two 20 cm (about 8 inch) pieces of #22 plastic-covered copper wire
three #48 bulbs
wire stripper

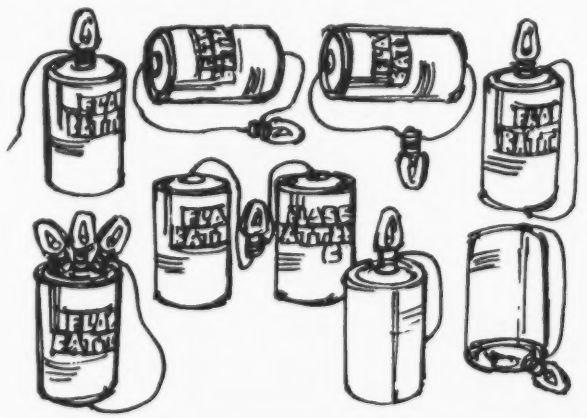
Directions
1. Using just one piece of bare wire, a battery, and a bulb, try to light the bulb.
2. After you get the bulb to light, try using the plastic-covered wire instead of the bare wire. Use the wire strippers to remove a few centimeters of plastic from each end of the wire.
3. Make these circuits. Find out which ones work.



SIMPLE CIRCUITS II — GUESS AND TRY

Here are eight different circuits. If you think the bulb will light, write a "yes" down near the circuit. If you don't think it will light, write a "no."

Now try each circuit to check your guess.



All circuit activities based on experiences described in **Batteries and Bulbs,** Elementary Science Study Copyright©1966, 1968. Education Development Center, Inc. All rights reserved. Used with permission. No endorsement given.

SIMPLE EQUIPMENT

If you made the circuits in "Simple Circuits" I and II, you may have noticed that it's hard to keep everything connected. To do more work on electricity, there are two simple bits of equipment that will help you keep the different parts of the circuit touching each other: a battery holder and a bulb holder.

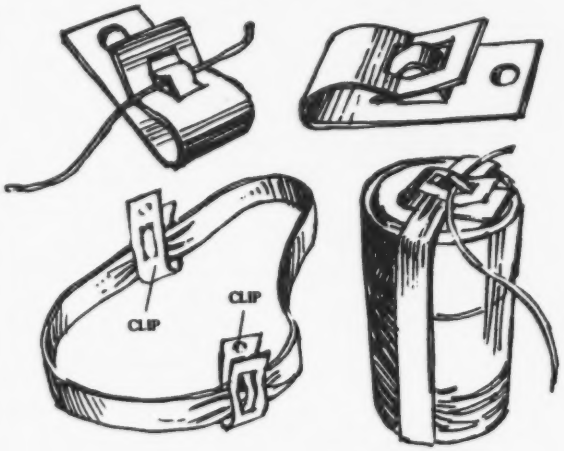
How To Make a Battery Holder

Materials

D battery
two 20 cm (about 8 inch) pieces of #20 bare copper wire
two Fahnestock clips (which you can get at a hardware store or radio-electronics store)
rubber band

Directions

1. Attach the Fahnestock clips to the rubber band.
2. Now put the holder on the battery. Be sure that one clip touches each end of the battery.
3. To try out your battery holder, put the end of a piece of copper wire through the loop in each clip. Now try to light the bulb.



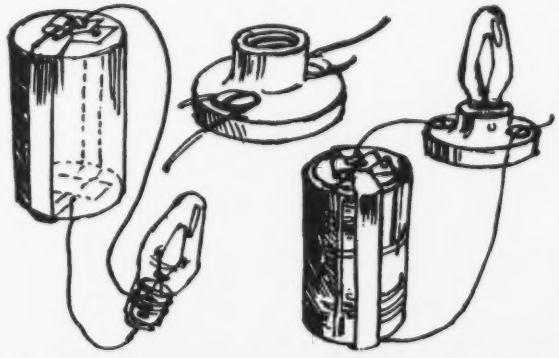
How To Use a Bulb Holder

Materials

two 15 cm (about 6 inch) pieces of #20 bare copper wire
#48 bulb
bulb holder
D battery and holder

Directions

Try to put together this circuit using the following: a battery, a battery holder, two pieces of wire, a bulb, and a bulb holder.



CIRCUITS — LESS SIMPLE

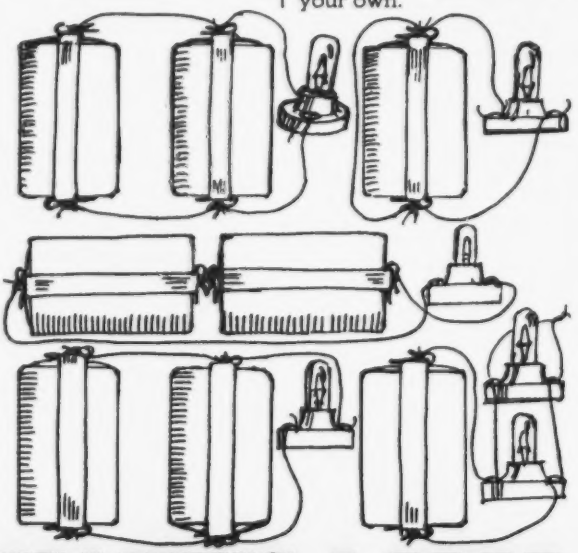
If you've enjoyed trying simple circuits, you might want to try some more complicated ones.

Materials

two D batteries
six 15 cm (about 6 inch) pieces of #20 bare copper wire
two bulb holders
two battery holders
two #48 bulbs

Directions

1. First take a guess about whether these circuits will work. Write down what you think.
2. Now make each circuit and check on how good your guesses were.
3. Invent some circuits of your own.



MAKING A BULB

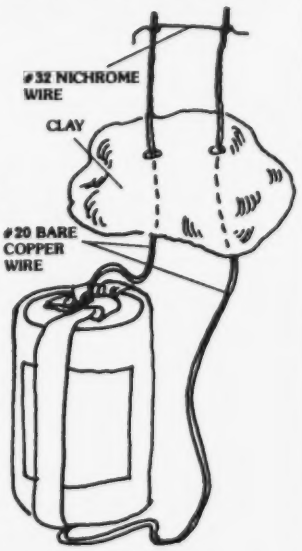
This experiment will help you understand how a bulb works.

Materials

two 20 cm (about 8 inch) pieces of #20 bare copper wire
8 cm (about 3 inch) piece of #32 Nichrome wire (which you can get in a hardware store)
5 cm (about 2 inch) ball of clay

Directions

1. Make a bulb using this drawing as a guide.
2. Attach two batteries to your bulb. What happens?
3. Use a longer piece of Nichrome wire. What happens?
4. Replace the Nichrome wire with a different kind of wire. What happens?



PENDULUMS

A pendulum is usually a piece of string that has a weight tied to one end. The weight can be a ball, a piece of wood, or even a small container of sand. The weight is called a "bob." The time it takes for the "bob" to go back and forth one time is called the "period."

Here are some pendulum activities.

Pendulum: Easy
Make a pendulum out of some string and a small weight. Attach the free end of the string to a hook at the top of a wooden support (or the top of a doorway).

1. What is the period of your pendulum? In other words, how long does it take for the bob to go back and forth one time?
2. How does shortening the string affect the period of the pendulum? Hold the bob the same distance from the center of its swing each time you change the length of the string.
3. Change the weight of the bob. How does an increase in the weight affect the period?

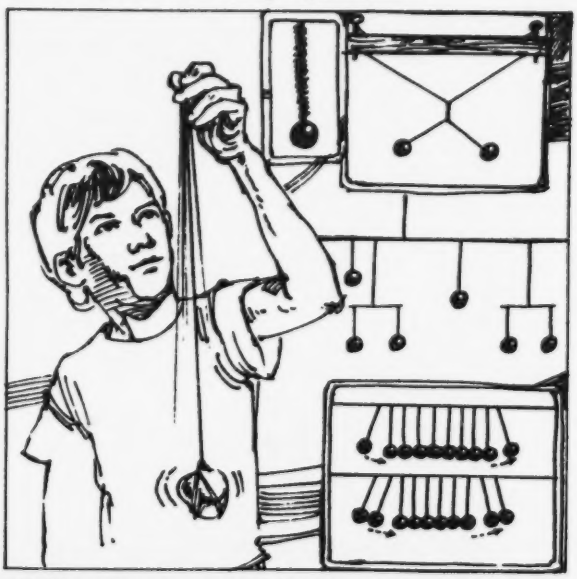
Pendulum: Odd
Make five pendulums that each have a different "bob." Now try to get them to swing together. What changes in the length did you make?

Pendulum: Circle Swinger
Make a simple pendulum with a string and a weight. Try to get the bob to swing in a small circle. What is the period of the pendulum when it swings in a small circle? How does it compare to the period of the bob swinging straight back and forth from the same distance as the diameter of the small circle?

Repeat this experiment, but have the bob make a large circle.

Pendulum Couples
Make two pendulums with the same kind of bob and lengths of string. Hang them side by side so the strings are 20 cm (8 inches) apart. Adjust the lengths so that you can get both bobs to swing together for five swings.

Now "couple" the pendulums by putting one elastic band around both strings. Start one bob swinging. How does it affect the other one? What happens if you move the rubber band higher or lower on the strings? What other experiments can you try with coupled pendulums?



From Pendulums, with minor revisions, © 1966, 1969, Education Development Center, Inc. Published by Webster Division, McGraw-Hill Book Co., page 33. No endorsement given. Used with permission.

PENDULUM ARTWORK

You can design a pendulum that actually draws beautiful designs. All you need are cone-shaped paper cups, salt, string, and some sheets of black construction paper.

Make a tiny hole in the bottom of the paper cone. Then cut three evenly spaced holes around the edge of the top of the cone. Now fasten a short piece of string to the top of the cone at each place that you have made a hole. Tie these strings to the bottom of a long piece of string.

Attach the long string to a hook in the top of a doorway. Be sure that the string is long enough to hold the cone just above the floor.

Place the construction paper under the cone and then fill the cone with salt. Swing the cone so that the pendulum leaves an interesting trail of salt on the paper.

To get even more interesting designs, try to make salt pendulums that are hung in different ways.

What kind of design do you get when you "couple" two salt pendulums?

Take photographs or make drawings of the different designs you make with salt pendulums. Or spread glue over the paper and set the pendulum in motion.

PENDULUM GAMES

PENDULUM BOWLING

Set up ten golf tees in the standard triangular bowling-pin arrangement. Make up your own rules for playing. You might start by asking each player to try to knock all the "pins" down in three swings, using a small ball as a bob.

The pins can be set up on a desk under a pendulum support or on the floor under a ceiling pendulum. You can also use a hand-held pendulum.

Keep score by keeping track of the number of "pins" knocked down in each three-swing attempt. Variations might include using a heavy bob, a light bob, and a tiny bob. Make each game harder and more demanding of skill than the preceding one.

PREDICTION ORBIT

Set up twenty or so tees in a group and swing the pendulum in an orbit around the outside of the group. After three orbits, can you predict which tee will be the last to be knocked over by the bob? You may change your prediction only once.

This can be played with a pendulum hung either from the ceiling or from a pendulum support.

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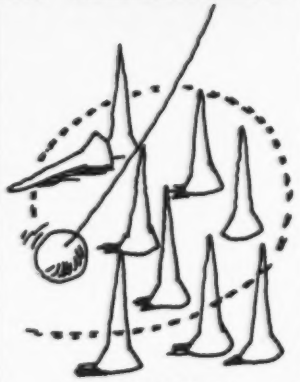
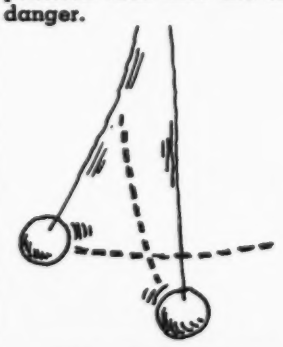


ORBIT GAME

Spread out twenty tees loosely beneath a pendulum. Set the pendulum swinging in an orbit. The object is to prevent the bob from hitting any tees. Keep your eye on the circling bob. If it looks as if the bob will hit a tee, pick up the tee and place it somewhere else in the group (inside or outside the orbit) where you think it won't get hit.

Try this with a ceiling pendulum.

Try this with two or three players. The players can station themselves outside the orbiting pendulum and, without leaving their places, can remove and reposition tees that are in danger.



CRISS CROSS GAME

Can you swing two adjacent pendulums — one back and forth, the other side to side — so that they do not hit for ten swings?

Can you do it for twenty swings?

Try this with two pendulums hung side by side and swinging in opposite circles — one clockwise, one counterclockwise.

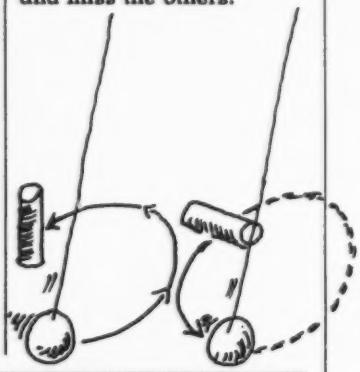
WIGGLE GAME

Set up a long row of golf tees, arranged so that they are progressively closer and closer together. As you walk alongside the row, swing the bob of a hand-held pendulum back and forth through the spaces between the tees. How far down the line can you get without knocking a tee down? Can you go down the line and come back through the spaces without stopping or knocking down a tee?

PEG GAME

Set up a dowel anywhere under a pendulum. Try to swing the bob so that it will miss the dowel on the way out but knock it down on the way back.

Set up several dowels and swing the bob so it will knock down some targets and miss the others.



Building a Soda Straw Balance

Materials

soda straw
long pin or needle
supports: a pair of tin cans or books or pieces of wood on which to rest the ends of the pin or needle
paper clips

Directions

Place the pin or needle on two supports so that it makes a bridge between the supports, as shown.

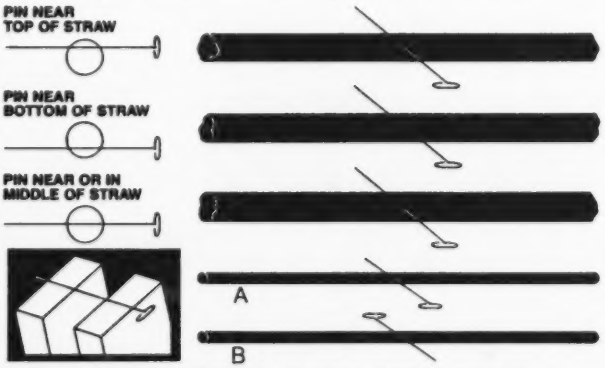
1. Can you balance the straw (make it stay level) by resting it *on* the pin or needle? Why or why not?

2. Can you balance the straw by pushing the pin through it?

3. If you have succeeded in balancing the straw, where is the pin — near the middle or near one end of the straw?

4. In which of these three positions (see diagram) is the straw easiest to balance?

5. Once you have balanced the straw, does it remain balanced when you turn it around as in A? Does it remain balanced if it is turned upside down as in B?



The three soda straw balance activities are from *Small Things* © 1967 Educational Services Incorporated, Webster Division, McGraw-Hill Book Co., pp. 57-61. No endorsement given. Used with permission.

Using a Soda Straw Balance

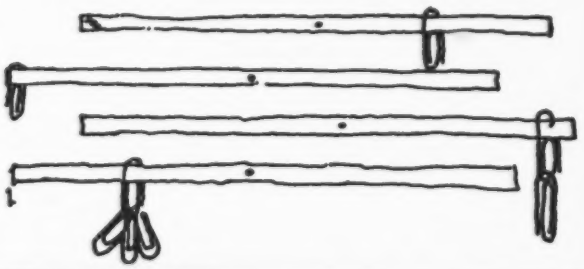
Hang a paper clip on one end of a balanced straw. Without removing the paper clip, what can you do to balance the straw? (If the paper clip slides along the straw too easily, try pinching the loops of the clip closer together so that they rub against the straw.)

Here are some drawings of one side of a straw balance. There are paper clips on the other side, too. Using your paper clips and straw balance, see if you can find out how the other side looks. Draw a picture of it by completing each of these four drawings.

Can you complete the four drawings by placing *only one* paper clip on the other side of the balance?

Can you complete the drawings using *two* paper clips on the other side of the balance?

Can you balance two paper clips near one end of the balance with one paper clip on the other side?



Making a Soda Straw Pan Balance

To weigh things other than paper clips on your balance, you need a place to put things: balance pans. Using a pin (to punch holes), thread, and paper cups, you can make a pair of balance pans like the ones shown here. Notice that the thread is tied on each side of the cup.

Now you need to make notches on the straw so you can hang the cups securely. Where should the marks be?

Use a serrated knife to cut little notches at the places you've marked. Be careful not to cut your finger.

You now have a balance that should look like the picture below.

1. Is your straw beam with the suspended cups perfectly balanced (level)? If not, why isn't it?

2. What things make your straw balance level?

3. Using a little piece of clay, how can you make your balance level?

4. How many things can you find that balance each other?

5. Find out which weighs more:

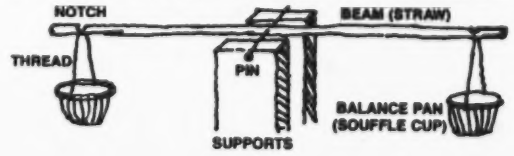
a. a nail or a washer?

b. a thumbtack or a paper clip?

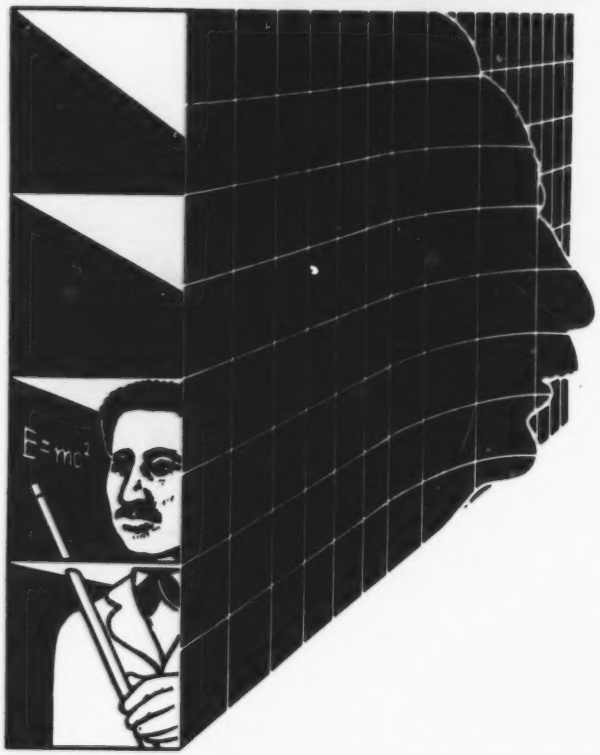
c. a new penny or an old one?

d. a paper clip or a pin?

6. What would happen if you tried to weigh a lead sinker on a straw balance?



ALBERT EINSTEIN, Master Scientist



Albert Einstein (1879–1955) loved music when he was a young boy growing up in Germany. He spent much time writing music for religious songs and learning to play the violin. His great love of music stayed with him all through his life.

This quiet, shy boy was only an average student in school, but he taught himself a great many things outside school. The subject that he liked to work on the most during his free time was mathematics.

In 1905 he wrote a paper on what he called his "special theory of relativity." In this paper he suggested that matter could be changed to energy. Most scientists thought he was wrong. Many years later, his ideas were proven to be correct.

As a Jew living in Germany, Einstein was threatened by the rise to power of the Nazis. At one point, they took all his property and burned his books. He moved to the United States in 1933 and became an American citizen in 1940.

All through his life the ideas that he wrote and spoke about were far ahead of what most people believed. Albert Einstein will probably be best remembered as one of the most important people in the history of science and of mankind. He was a shy and gentle man whose ideas have shaped the world in which we live.

1. Are you surprised that this scientist was interested in music and religion?

2. What subjects interest you most in school? Which ones interest you least? Einstein taught himself many things when he was not in school. Are there any things that you are teaching yourself?

CHARLES STEINMETZ, MASTER OF ELECTRICITY

Charles Steinmetz (1865–1923) was a strong believer that work is doing something unpleasant. He spent 12 to 14 hours a day studying and experimenting with electricity but never considered this to be work because he liked it so much. Steinmetz contributed a wealth of ideas to the theory and practice used to construct electric motors, generators, and transformers. In his later years, he was paid an unlimited salary by his bosses at the General Electric Company because they were so pleased with his theories and inventions.

Steinmetz was almost denied admission to the United States in 1889 because he was barely 4 feet tall, having been born with a spinal curvature. The immigration authorities thought that the admission of physically weak people would make the country weak. The friends of Steinmetz had to argue long and hard before he was admitted to the United States. Very soon thereafter he became a citizen.

His first job in the United States was as an electrical draftsman. It was during this time that Steinmetz discovered an important mathematical law relating to changes in magnetism in rotating magnetic fields. His fame grew rapidly, although it was many years before his salary became unlimited. During the 34 years he lived in the United States, he worked on over 200 inventions for the General Electric Company, taught classes at Union College, and wrote several books.

The pioneering work of Steinmetz is an interesting example of how work with fundamental ideas leads to changes in human life style. How many times today have you depended on electric transformers, motors, and generators?

1. What is being done in your community to eliminate discrimination against people who are physically handicapped?

2. The chairman of the board of directors of General Electric Company told Steinmetz that he could do anything he wanted while working for the company. He said, "Dream all day, if you wish. We'll pay for your dreaming!" What do you think of this? Carry out a brief survey, asking other people whether they would pay an employee as G.E. did Steinmetz if they were the head of a company.

From *People, Concepts, Processes Science 5* by Holmes et al., © 1974 Webster Division, McGraw-Hill Book Co., page 222.

CHAPTER 12

SKY FLIERS

A hang glider beautifully rises along an upward-moving column of air and then begins a slow spiral dive downward, piloted by someone who has the courage to try to defy gravity.
A sky-diving daredevil hurtles downward through the air and then . . . snap! . . . a beautiful orange parachute pops open and slows this daredevil's fall.
Men and women have been trying to soar like birds for centuries. Whether it be airplanes, hot-air balloons, hang gliders, parachutes, or rockets, they have all given humans a chance to free themselves of the earth — and fly!
Would you like to build a flying machine? This section of the book will help you learn about flight by building and flying hot-air balloons, giant paper airplanes, kites, balsa wood gliders, and parachutes. Come along — and fly!

GO FLY A KITE!

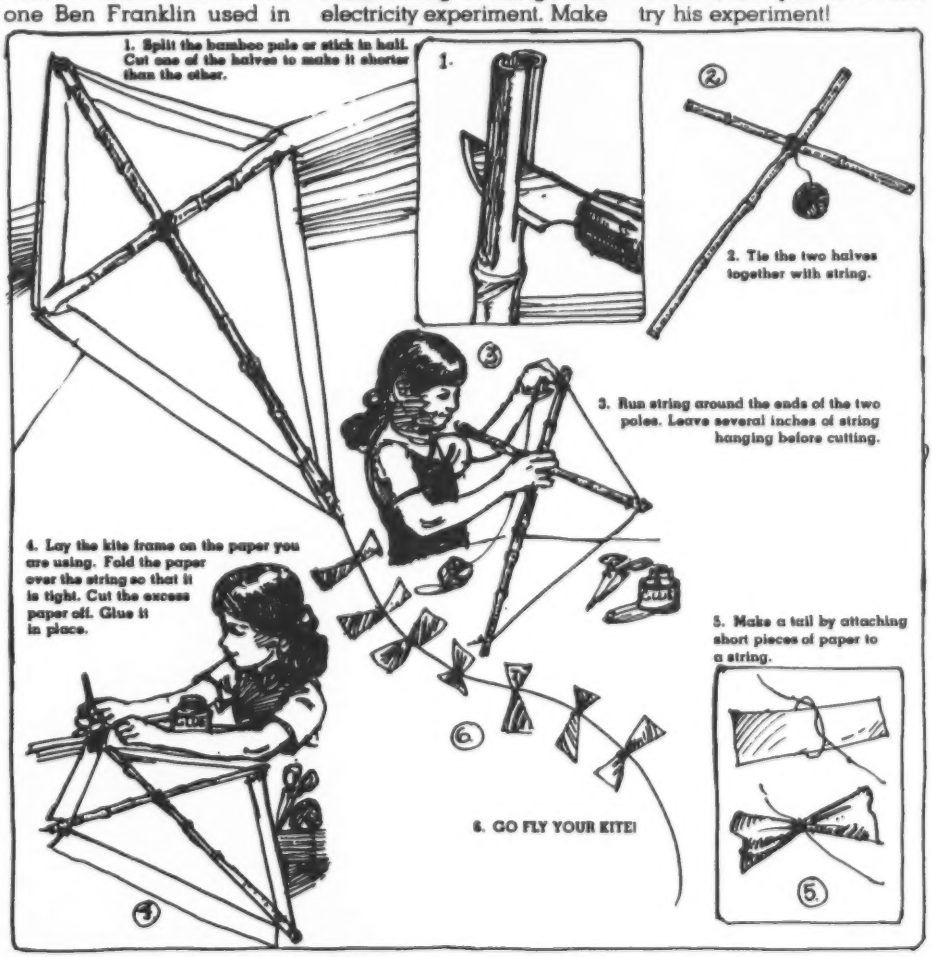
The kite has been with us for more than two thousand years, longer than any other toy except the doll. But to call the kite only a toy belies the richness of its history. It has been a military tool used to send messages during battle and to vault men over enemy lines; it has been an envoy of lovers' notes and an oracle of sacred respect. Fishermen of the western Pacific still use kites as long distance fishing poles which do not cast shadows to frighten away the timid catch; and scientists from Ben Franklin to meteorologists have been grateful for the kite's aid.

(From Come Fly A Kite, Inc., San Francisco, California)

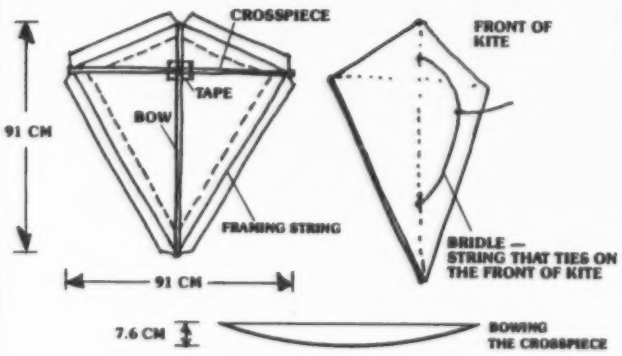
Naturally, you can go to a department store to buy a kite, but we'd rather have you build your own. Here are a few types that you may wish to try. For these kites you will need only a long, flexible stick (bamboo is good), glue, some paper (tissue paper, butcher paper, newspaper, plastic), and plenty of string.

BEN'S KITE

Here's a kite much like the one Ben Franklin used in 1752 during a dangerous electricity experiment. Make the kite, but please do not try his experiment!


1. Split the bamboo pole or stick in half. Cut one of the halves to make it shorter than the other.
1.
2.
2. Tie the two halves together with string.
3
3. Run string around the ends of the two poles. Leave several inches of string hanging before cutting.
4. Lay the kite frame on the paper you are using. Fold the paper over the string so that it is tight. Cut the excess paper off. Glue it in place.
GLUE
4
6
6. GO FLY YOUR KITE!
5. Make a tail by attaching short pieces of paper to a string.
5

EDDY KITE



This is a very simple kite that requires no tail. You can build yours much larger than shown here. Just scale it up by using the proportions given. To build this kite you will need two sticks (0.5 cm × 0.8 cm × 91 cm), string, light-weight paper, and masking tape. To make the kite follow these directions:

1. Mark the midpoint of the cross stick. Be sure this stick is flexible.

2. Mark 17 cm down on the vertical stick.

3. Cross the sticks at right angles at the marked points. Glue and tie the sticks together.

4. Tie a loop at the end of the framing string and slip it through the top notch. Weave and tie through each notch all around the kite and back to the top. Keep the sticks at right angles. (Use small square cards to check the angle as construction proceeds.)

5. Lay the frame on paper, cross sticks down, and trim, allowing a 2 cm flap to glue over the string. Crease the flaps over the string and miter the corners so the stick ends are free and layers of paper don't build up.

Margaret Gregor, "Kite Curriculum," *Learning Magazine*, March 1975. Copyright © 1975 Education Today Company, Inc., Palo Alto, California. Used with permission.

6. Glue the flaps over the string.

7. Tape paper under the center crosspiece to reinforce the holes for the bridle.

8. Make holes as shown in the illustration. The bridle ties on the front of the kite, down and up over the crossed sticks. Tie the other end through the notch at the bottom. The bridle string should be one and a half times the vertical length of the kite.

9. Bow the kite. Two people make it easy: One person bends the crosspiece like stringing a bow; the other slips a loop over the notch at one end and ties the string through the notch at the other end. The distance from the bowstring to the center of the kite should be about 3 inches.

10. The bridle angle must fit the wind-of-the-day. A light wind calls for more kite surface (higher bridle loop); a strong wind needs a reduced surface. Hold the bridle by one finger and see what the wind wants.

11. Well-made Eddy kites fly without a tail, but if some kites cannot be balanced by changes in bow and bridle, a length of tail will give needed stability.

THE SNAKE KITE

This is an example of an Oriental kite. The design that you will follow includes a 3 meter crêpe paper tail that makes this kite an exciting one to build and fly. Here's what you need:

30 cm × 40 cm piece of tissue paper
12 cm × 3 m piece of crêpe paper
matchstick bamboo reed (about 72 inches long)
scraps of bamboo for spine and crosspiece
152 cm string (60 inches)

1. Make this pattern on newspaper.

2. Trace the pattern on tissue and cut it out.

3. Measure the reed by bending it around the curved edge of the tissue, about ¾ inch in from the edge, ending about 1½ inches from the bottom (straight) edge on each side. Break off the correct length.

4. Spread glue on the outer 1 inch of curved edge only. One person holds the reed in place around the arch while another folds the glued tissue over it; this will keep the kite face flat.

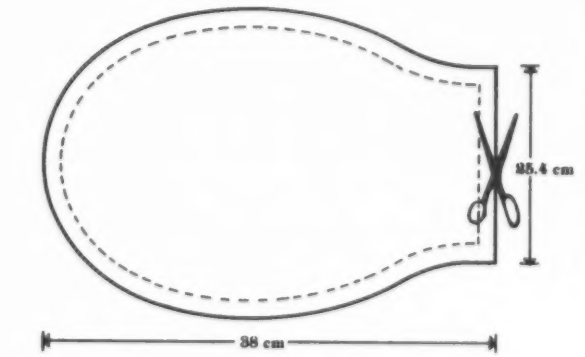
5. Mark a vertical line down the middle of the kite. Cut a reed to run down this line from the top of the arch to 4.2 cm from the bottom of the kite. Cover with a 5 cm strip of glued tissue.

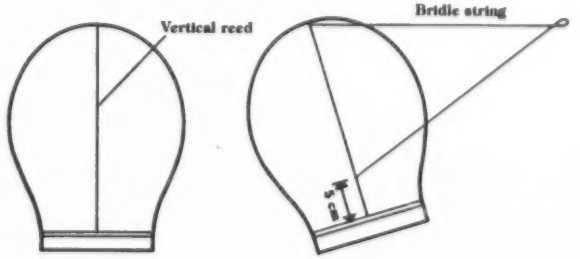
6. Cut two reeds to fit between the ends of the arch. Cover with glued tissue.

7. Turn the kite over. This is the front. Make holes for the 152 cm bridle string and tie over the reeds as shown here.

8. Glue the tail to the paper flap at the bottom of the kite. If this is a flying day, a good way to find the correct bridle angle is to let the wind do it. Hold the bridle string over one finger and the wind will lift the kite to a good flying stance. Tie a loop here. The flying line is tied on through the loop. In a very light breeze the tail may have to be shortened.

Margaret Gregor, "Kite Curriculum," *Learning Magazine*, March 1975. Copyright © 1975 Education Today Company, Inc., Palo Alto, California. Used with permission.





KITE PHILOSOPHIES

Though King Gupta lived very long ago, he was very much like many modern people, for he could find no real happiness in anything. With his great wealth he collected fabulous treasures. With great power he attracted many glamorous people. And with his keen mind he mastered all the arts.

"But there must be something more," he sighed in his loneliness.

Hearing of the sad plight of the king, a sage old doctor went to the palace one day with a fighter kite under his arm. He challenged the king to a pench and the king lost. From that day on, the king was seen constantly practicing kite maneuvers from the palace walls. No one knows if he ever beat the old doctor.

But something did happen to the lonely king. Through nothing more complicated than a kite, the king regained the pleasure of joyful play, and by watching his kite in the sky, he rekindled the flame of contemplation. Years later, after a rich and happy life, the king left his people this message written above his palace gate:

my kite is like the morning star
an early candle in the sun
my kite is beauty
on the back
of a rolling wind

Courtesy of Come Fly A Kite, Inc., San Francisco, California

DINESH BAHADUR, MASTER KITEMAN

Dinesh Bahadur's interest in the world of kites began when he was three years old. At twelve he could claim the Kite Fighting Championship of India, and later he captured the international title. In attempting to fulfill his lifelong dream for every person to experience the joy of kite flying, Dinesh cheerfully spends countless hours teaching children, young and old, the true art of kite flying.

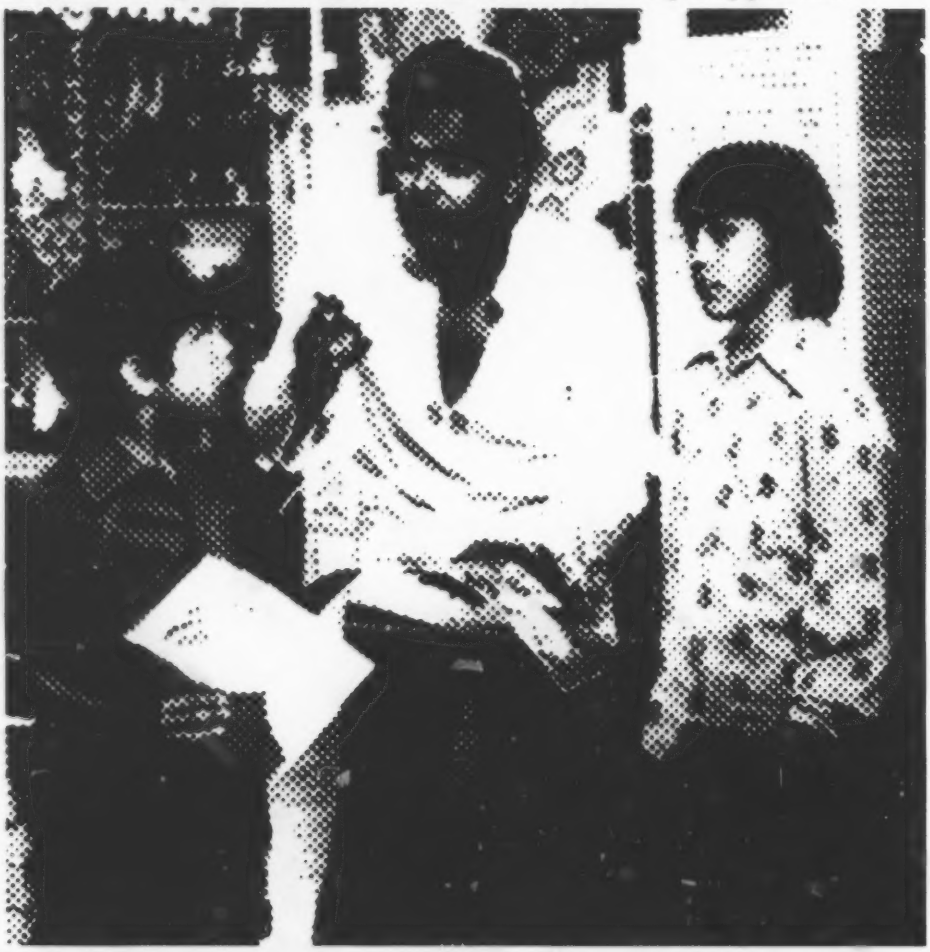
At one of the many festivals he attended, Dinesh set a record of placing his kite at the highest altitude, 4,000 feet, as well as having the largest kite — the 150 foot dragon — and capturing the grand prize for the best designed kite in the show. Later, in the first international kite-flying championship, he won twenty categories of kiting achievement with a single Indian fighter kite and was awarded the title of Master Kiteman.

In San Francisco in 1975, Dinesh set a record that was entered in *The Guinness Book of World Records*. Without the use of a tail, wind source, or running, he flew a ten-year-old Indian fighter kite *inside* a hotel for 32 minutes and 9 seconds!

With so many uses, both past and present, it makes one wonder why we haven't seen even more people enjoying kites in their many forms; but nourished on the desire of all people to play in the sky, and guided by the aid of a master, Dinesh, kites are billowing out above our skylines and hillsides, our beaches and housetops, as an emblem of a new-found but very old pleasure.

1. Using your own ingenuity, gather materials from outside to make a kite. (Psst! You're not allowed to purchase anything from a store.)

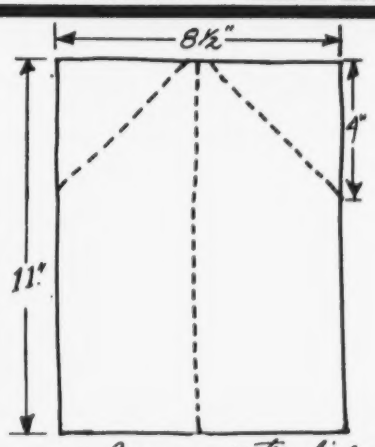
2. Go outside today and fly a kite. Become aware of your feelings and thoughts as you fly your kite.



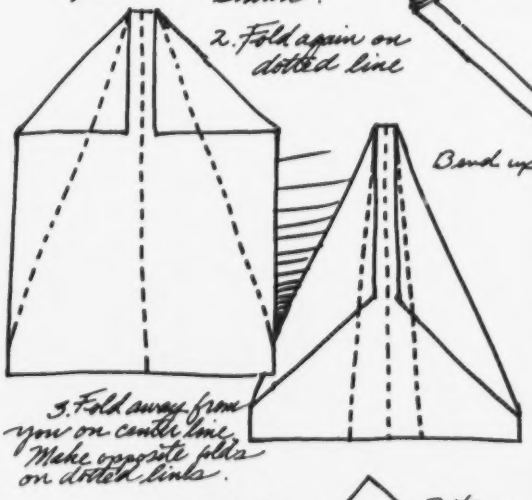
PAPER AIRPLANES

THESE TWO MODELS ARE RELATIVELY EASY TO MAKE. THEY WERE BOTH WINNERS AT THE FIRST INTERNATIONAL PAPER AIRPLANE COMPETITION, SPONSORED BY **SCIENTIFIC AMERICAN** ON JANUARY 21, 1967. TO MAKE EACH OF THESE PLANES, ALL YOU NEED ARE TWO SHEETS OF PAPER AND A PAIR OF SCISSORS.

From **The Great International Paper Airplane Book** by Jerry Mander, George Dippel, and Howard Gossage. Copyright 1967 by the Shade Tree Corporation. Reprinted by permission of Simon & Schuster, Inc.

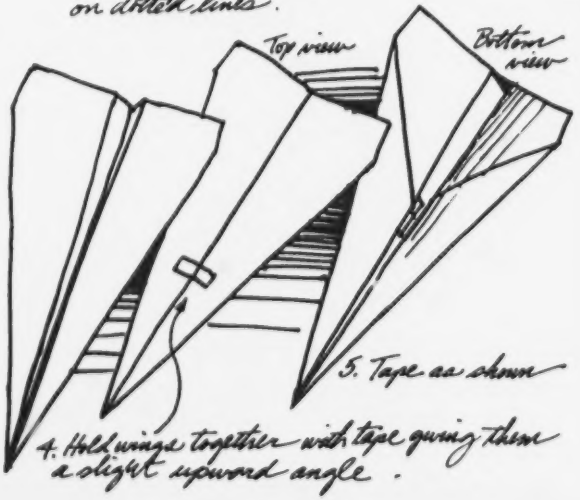


1. Crease on center line. fold corners in as shown.



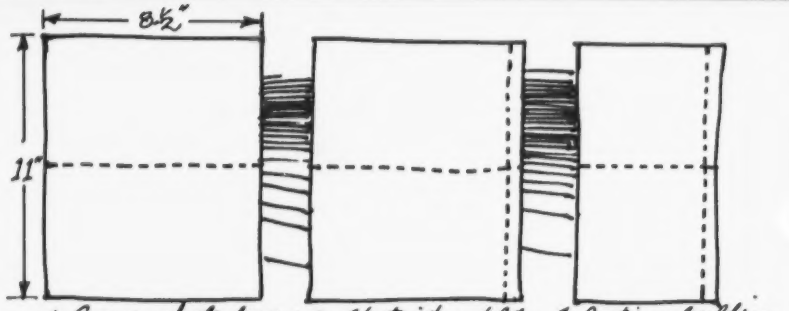
2. Fold again on dotted line

3. Fold away from you on center line. Make opposite folds on dotted lines.



5. Tape as shown

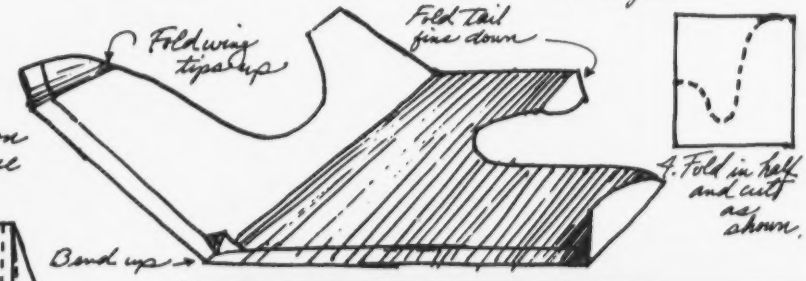
4. Hold wings together with tape giving them a slight upward angle.



1 Crease sheet down center

2. Start with a fold of about ¼"

3. Continued folding until about 4½" are left.



4. Fold in half and cut as shown.

PARACHUTES

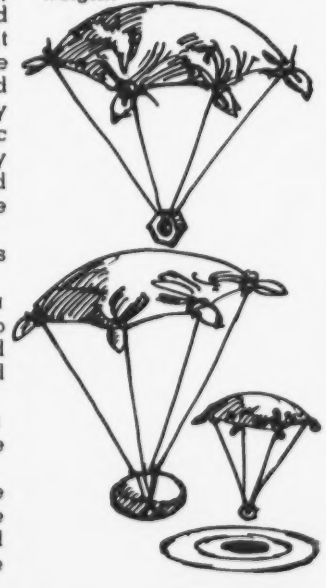
Parachutes can be made using a variety of materials. Tissue paper, plastic wrap, and baggies are good starter materials. Giant parachutes can be made out of the plastic wrap used to cover clothes at the dry cleaners. Keep all plastic bags out of the reach of very young children. With thread and some weights, you're all set to jump!

Here are some challenges for you:

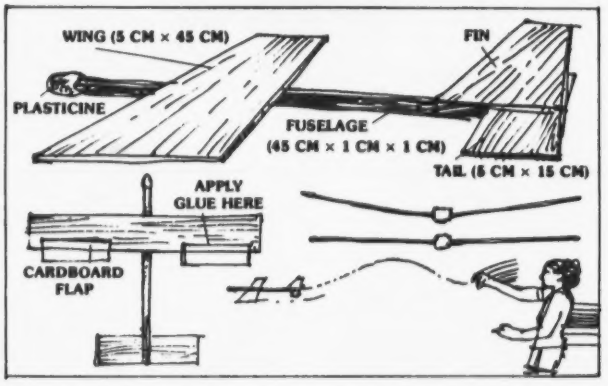
1. Can you design a parachute that falls so slowly that an uncooked egg attached to it can land without breaking?

2. Can you drop a parachute 10 feet onto the bull's-eye of a target?

3. Can you increase the weight that your parachute will hold and still descend slowly? Can you increase the weight of the object by three times the original weight?



GLIDERS



Gliders are easy to build, although they will take a little more patience. Obtain corrugated cardboard, one strip of balsa wood 5 cm × 76 cm × 1 cm (for wings and tail), another piece of balsa 40 cm × 76 cm × 1 cm (for fuselage), a single-edge razor blade, glue, and plasticine.

Be sure to place the balsa wood over the cardboard before cutting. This will prevent unnecessary cuts and scratches to tables.

The simplest model glider is shown above. You can modify this model by making it smaller or larger. You'll have to experiment with plasticine (adding or removing small amounts) to attain balance for the glider. Several test flights will be needed.

Once you have your glider built and flying, you can study many of the things that affect the flight of airplanes. Airplanes have flaps on their wings and tail. You can make flaps by attaching strips of cardboard about 8 cm long and 2 cm wide (masking tape folded over will also do).

With the two flaps and a rudder attached to your plane, you can now do several experiments to determine the effect of changing the angles of each flap. See if you can answer these questions by doing a few experiments with your glider:

1. What happens to the plane with the flaps down?
2. What happens when the flaps are up?
3. What does the plane do when the flaps are even but the rudder is bent to the left? To the right?
4. What happens if one flap is up and the other is down?

You may have to build more models to investigate these additional questions:

1. How do the length, width, and shape of the wings affect the flight of a plane?
2. How does the angle of the wings affect the plane's flight and stability?
3. How can you design a plane without a rudder?
4. How long should the fuselage be, compared to the size of the wings, to get maximum range?
5. How does the wind affect the flight of a plane?

AMELIA EARHART Pilot

Amelia Earhart (1898-1937) was one of the most famous pilots of our century. She flew for the fun of it, but pride, achievement, and will motivated her exploits in the sky. She became famous in 1928 when, flying from Newfoundland to Wales, she became the first woman to fly across the Atlantic Ocean. In 1929 she flew across the United States, from New York to Los Angeles, and became the first woman to do so alone.

Amelia Earhart — a free spirit and a woman able to decide for herself what she would do with her life — illustrated what a human being can become.

In 1937 Amelia Earhart planned to fly around the world. She left Miami and flew to New Guinea and from there planned to fly to a small island in the Pacific. Amelia Earhart was last heard from saying that her gas was running low as she approached the island. She never landed, and no one knows for sure what happened to her. But we do know that she was one of the important persons of our century because she was willing to take risks so that she could grow to be the person she wanted to be.

1. **It takes courage to be what you want to be, whether you are a boy or a girl. What's important to you right now in your life? What are you doing to make happen what you wish for yourself right now?**
2. **What do you think happened to Amelia Earhart?**

DO-IT-YOURSELF HOT-AIR BALLOONS

The first hot-air balloon was launched on June 5, 1783, by Joseph and Jacques Montgolfier.

Hot-air balloons work on the principle that less-dense air will rise or be pushed up by the more-dense air around it. Heating the air inside the balloon makes the inside of the balloon less dense (lighter) than the surrounding air. When this happens the balloon rises.

The Baggie Type

One type of hot-air balloon you can build uses the following equipment:

large plastic dry-cleaning bag
plastic straws
heat source (candle or alcohol burner)

1. Measure the width of the open end of the plastic bag.

2. Join the plastic straws together until they are twice the width of the open end of the plastic bag. You may have to pinch one end of each straw to insert it into the adjoining ones. Form a hoop when you complete connecting all the straws.

3. Loop the open end of the bag about 3 cm over the plastic-straw hoop. Fasten with tape.

4. Collect hot air in your balloon by placing a candle or alcohol burner beneath it. You'll have to support the bag while the air inside is being heated.

The Paper-Tissue Type

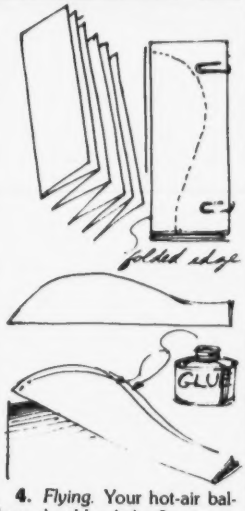
Another type of hot-air balloon is made of wrapping paper. (That's right, holiday or birthday paper!) The tissue-type wrap is best because it is more flexible and lighter.

You will need six sheets of paper at least 20 cm × 10 cm.

1. Fold each sheet in half lengthwise and stack them. Put paper clips on the edges to hold them together.

2. Draw a pattern on the top sheet as much like the one shown as possible. Cut along the line you have drawn.

3. Glue all the pieces together. Place one sheet on a newspaper and apply glue along the edge. Place another piece on top of the glued piece. Repeat the glueing process until all six pieces are joined. As a last step, glue the two ends together, so that all edges are joined. After it has dried completely, inflate the balloon with forced air from a hair dryer.



4. *Flying.* Your hot-air balloon should only be flown outside and on a cold day with little or no wind. The setup for flying your hot-air balloon will look like this picture (you'll need to assemble the burner, which requires only two cans of different sizes with holes cut to allow the heat from the sterno to fill the balloon).

Notes About Flying

1. Have at least three people: one to watch the burner, one to hold the balloon steady, and one to take pictures!

2. Never attach the burner to the balloon.

3. Allow the balloon to inflate with hot air, then release it.

A BALLOON ROCKET

To help you understand how rockets work, start with a balloon. You'll also need about 10 feet of string, some masking tape, and a straw.

1. Slide the string through the straw and then tie it between two objects (chairs; or, if you do it outside, trees or poles).

2. Attach a balloon to the straw with masking tape. Blow the balloon up and let it go!

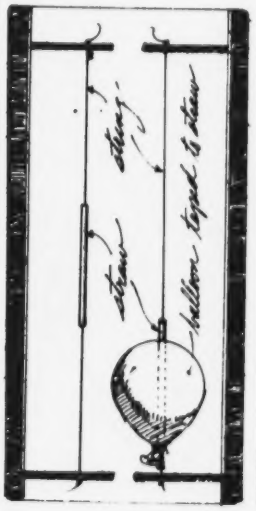
Experiment to find the answers to these questions:

1. What is the farthest distance your balloon rocket goes on the string?

2. What happens if you put only half as much air in the balloon?

3. What causes the balloon rocket to move?

4. What happens to the distance your rocket moves if you use different sizes and shapes of balloons?



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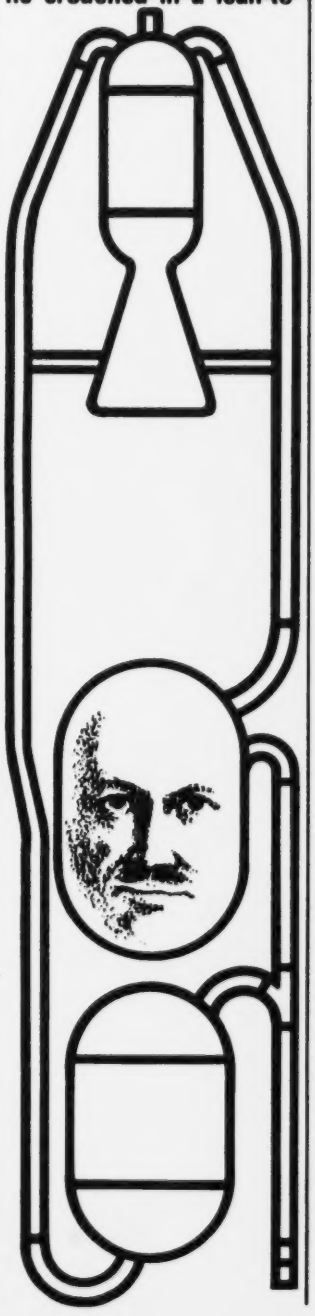
BEST COPY AVAILABLE

ROBERT GODDARD ROCKET INVENTOR

On March 6, 1926, Robert Goddard (1882–1945) launched the first liquid-propelled rocket from a snowy field at Auburn, Massachusetts. It was ignited by a blowlamp while he crouched in a lean-to shed nearby. It was just as private an occasion as the Wright brothers' flight, lasted seven or eight seconds longer, and flew a few yards further (184 yards). In the long run it may well prove the more important.



Goddard was an American scientist whose original interest had been high-altitude research. Seven years before, just after World War I, he had published the mathematics and design for meteorological research rockets. He was considered a crank by the scientific establishment because of his crazy ideas on "space travel" and his casual suggestion that such rockets could be used to land a charge of flash-powder on the moon. But he continued working, with the help and money of a few friends.

His atmosphere research resulted in two advances in rocketry: the major technical breakthrough in propellants and an even more important redefinition of purpose — following Goddard's research, science claimed rockets as a vital and legitimate research tool (quite apart from their more aggressive uses).

1. Goddard was considered a great inventor. The dictionary defines "invention" as a product of the imagination. Write or draw some things you've imagined that might be turned into inventions.

2. People who are "cranks" or have "crazy" ideas are often put down by society. List and discuss experiences about this idea.

3. Search through this book for other scientists who were considered cranks. What were they famous for?

John Chesterman, et al., *An Index of Possibilities, Energy and Power*, copyright 1974, by Pantheon Books, a division of Random House, Inc., New York, page 42.

FLIGHT BOOKS

The Airplane and How It Works by David Inglis Urquhart. New York: Henry Z. Walck, Inc., 1973, $4.50.

The End of the World by Franklyn M. Branley. New York: Crowell, 1974, $5.50.

The Great International Paper Air Plane Book by Jerry Mander, George Dippel, and Howard Gossage. New York: Simon & Schuster, 1967, $2.95.

Into Space: A Young Person's Guide to Space by Arthur C. Clarke and Robert Silverberg. New York: Harper & Row, rev. ed., $3.95.

"It Is I, Sea Gull": Valentina Tereshkova, First Woman in Space by Mitchell R. Sharpe. New York: Crowell, 1975, $5.95.

Kiting: The Basic Handbook of Tow Launched Hang Gliding by Dan Poynter. Santa Barbara, Calif.: Parachuting Publications, 1974, $3.95.

Model Rocketry: Hobby of Tomorrow by Peter Lowry and Field Griffith. Garden City, N.Y.: Doubleday, $4.50.

The Sights and Sounds of Flying by Henry Humphre. Boston: Little, Brown, 1972, $7.95.

Skylab by Charles Coombs. New York: Morrow, 1972, $3.78.

Who Really Invented the Rocket? by Walter B. Hendrickson Jr. New York: Putnam's, 1974.

Ann Whitaker, Physicist

Photo courtesy of NASA

Ann Whitaker is a physicist who is now involved in designing and doing experiments for the NASA Spacelab that will be part of the Space Shuttle Orbiter during the 1980s.

Ms. Whitaker received her bachelor of science degree in physics and mathematics from Berry College, Mount Berry, Georgia, and her master of science degree in physics from the University of Alabama in 1968. She has been a member of the NASA Marshall Space Flight Center since 1963 and is the author of many papers and technical publications.

At the present time, Ann Whitaker is her laboratory's lead engineer for the Atmospheric, Magnetospheric and Plasmas in Space (AMPS) program.

1. Look up the word "physicist" in a dictionary. Now take a guess at the meaning of the word "astrophysicist." Check this in the dictionary also. Do you think Ann Whitaker could be called an astrophysicist?

2. Do you think scientists very often need to be able to put their ideas and discoveries into writing? Have you ever thought that scientists spend time just writing? Did you think that they spent all their time doing experiments?

3. What do you think a "lead engineer" does? What kinds of skills besides science and math would you expect a lead engineer to have?

CHAPTER 13

FAR OUT

We are in the midst of the Space Age. Humans have developed telescopes large enough to see things that we never even knew existed before. Some astronomers are sending signals into space using huge radio telescopes to try to find out whether intelligent life exists elsewhere in the cosmos. And, of course, rockets have been developed to land humans on the moon and to send space vehicles on long journeys out of our solar system.

Earth is a lonely planet twirling through space, like a spaceship. You, like astronomers, can look skyward to discover the beauty and harmony of the universe that will make your journey less lonely.

A GALAXY OF ACTIVITIES

Here is a collection of "far out" activities for you to try.
Each galaxy takes you into the world of both astronomy and astrology.

Keep a record of your horoscope for at least two weeks. How accurate is it?

Make random patterns of dots on a sheet of paper. Give the paper to someone and ask her to find "constellations." What kind does she find?

Pretend you are the sun. Describe or act out how it makes you feel to be the sun.

Go out in the playground and play a game of shadow tag. You're it!

Have a debate on the merits of astrology versus the merits of astronomy. Research this before you discuss it.

Get a book showing the constellations. Go out some night and find at least three. (Come on . . . at least the Big Dipper!)

Create a huge sundial on your school grounds.

Read a book on UFO's. Get together with people who have also read the book and have a discussion on UFO's.

Create a calendar based on the motion of the moon.

Group the people you know by their birth signs. Have them find out ways they are alike and ways they are different.

Go out at night with a telescope and art materials and paint a picture of the moon.

On a sunny day, go outside with friends and use mirrors to send signals to each other. Invent a code system.

Sit in the center of a room with your eyes closed. Imagine you are the center of the universe. How does this make you feel?

Meet a group of people some clear night and just watch the sky for an hour or so. What do you see?

Cut out daily newspaper astrological forecasts without birthdates. Have people choose which one fits them.

BENJAMIN BANNEKER, EARLY AMERICAN SCIENTIST

Benjamin Banneker was born and raised on a farm in Patapsco Valley, Maryland. He attended school until he was fifteen and went on to teach himself algebra and geometry. While still at school, he developed a particular interest in mathematics and astronomy.

His interest in the natural sciences was brought to the attention of a man named George Ellicott, a businessman and amateur scientist. Banneker's friendship with Ellicott stimulated his interest in astronomy, and at the age of fifty-six he began the study of astronomy. In the years that followed Banneker mastered the fundamental principles of astronomy, much to the surprise and pleasure of Ellicott. He could, for example, project forthcoming eclipses with extreme accuracy.

Banneker began preparation of an almanac to be used in the states of Maryland, Virginia, Delaware, and Pennsylvania. He published his first almanac in 1792, and for the next ten years he continued to publish this indispensable pamphlet. Almanacs were first introduced in colonial America in 1639 and played a very significant role in a society in which nearly everyone lived on a farm. In addition to calendars and information on heavenly bodies, these early almanacs contained information on astrology, history, literature, and poetry. Everybody in colonial America relied on almanacs for accurate information.

Because it was so important in colonial life, Banneker's almanac was a most welcome contribution. It soon became as popular as Benjamin Franklin's *Poor Richard's Almanac*, published years earlier.

The achievements of Benjamin Banneker in science, mathematics, and astronomy have often been considered as symbolic of what black Americans could have accomplished if given the opportunity.

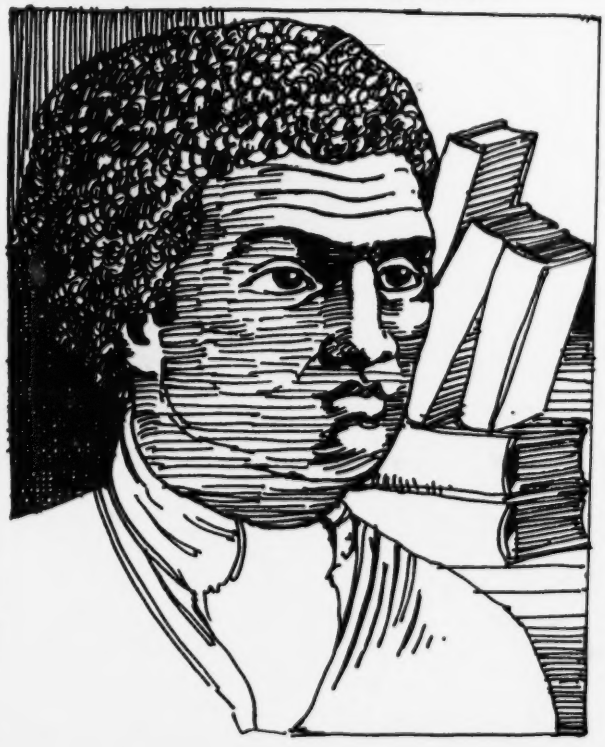
Benjamin Banneker became so absorbed with his scientific research that he found farming too demanding and eventually leased his land to several farm families to help supplement his meager income. Wealth did not accompany the fame he achieved.

Banneker was often compared to Benjamin Franklin, who also engaged in scientific research and published almanacs. Banneker died in 1806, an American scientist whose color made him a "forgotten man."

1. Obtain a copy of a current almanac. What type of information does it contain?

2. Research contributions made by other black American scientists.

3. Racial prejudice has been, and still is, one force preventing people from developing fully and making contributions to all of humanity. What are some of the other forces?



Edward S. Jenkins et al., *American Black Scientists and Inventors*, copyright © 1975 National Science Teachers Association, Washington, D.C., pages 23-26. Used with permission.

HELLO OUT THERE!

What would you say if you were asked to plan and send a message into outer space? You don't even know to whom or to what you're sending this message.

Try this guided fantasy trip to help you create such a message.

Close your eyes and relax. . . . I want you to imagine that you are working with a team of scientists trying to make contact with intelligent life in the universe. . . . How does this make you feel? . . . What would you want to communicate to these beings? . . . Think for a few minutes about this. . . . Is it a written message, a code, a picture, a map, or something else? . . . Now imagine sending the message. . . . How do you think those beings will react to your message? . . . Now slowly come back to this room and open your eyes. . .

Write the message that you created in your fantasy trip on a sheet of construction paper. If your message was a picture, make a drawing of it. Now discuss and share your message with two or three other people.

GALILEO GALILEI, ASTRONOMER EXTRAORDINAIRE

Galileo, born in 1564, was the creator of the modern scientific method. Although he did not invent the telescope, he improved the Flemish invention by stepping the magnification up from a power of 3 to a power of 8 or 10 and then up to a power of 30. When he did that, he turned his telescope to the stars.

As an astronomer, Galileo made his own observations instead of relying on accepted opinions based on the ancient Ptolemaic theory of the solar system, which held that the sun and planets revolved around Earth. In 1610 his telescope provided him with strong support for the Copernican theory, which stated that Earth and the other planets revolved around the sun. Finding four moons revolving around Jupiter, Galileo realized that Earth was not the only center of motion. Venus' moonlike phases also fitted the Copernican but not the Ptolemaic system.

Galileo's belief in the reality of the Copernican system, however, brought him into direct conflict with official Church policy, which supported Ptolemy. Galileo was called before the Inquisition in 1633 and was forced to retract his views. Until his death in 1642, however, he privately worked and wrote according to his beliefs.

1. Why do you think people were upset by Galileo's idea about the earth's revolving around the sun?

2. Have you ever been critical of a new idea you've heard about?

3. If you could ask Galileo one question, what would it be?

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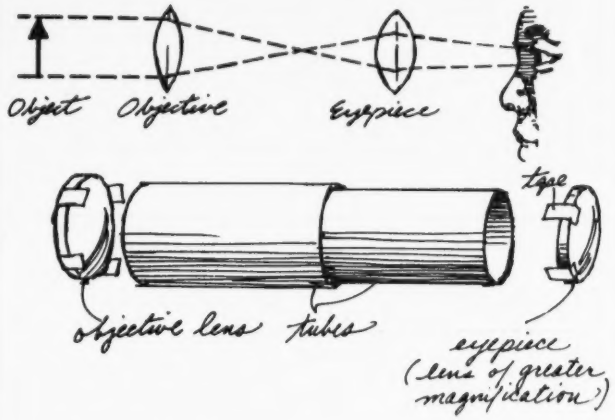
MAKING A GALILEO-TYPE TELESCOPE



That's right. You can do what Galileo did. You will need two lenses (with different magnifications), two sheets of construction paper, and some tape.

1. Hold the lens with greater magnification (the eyepiece) near your eyes. Hold the other lens (the objective lens) at arm's length. Move the objective lens in toward the eyepiece until you get distant objects in focus.

2. Roll the construction paper to form two tubes the size of the lenses. The tubes should fit into each other. Tape the lenses to the ends of the two tubes. Fit the smaller tube inside the large one.

3. Examine objects by looking through your telescope. Focus by sliding the smaller tube in or out. What do the objects look like?

You can use your telescope to:

1. Examine distant objects, buildings, and landscapes.

2. Look at the moon, and make water-color paintings of what you see.

3. With a star finder, locate the positions of planets and look at them. Can you answer these questions? "Does Jupiter have a red spot?" "What do the rings of Saturn look like?" "What planets have moons?"

Star Finder
63872-06 $2.45

This easy-to-use star finder is great for helping you locate constellations and stars in the sky on a clear night. Available from Science Kit.

Optics Kit
66335 $11.85

If you've always wanted to build a telescope, here's a kit you'll be interested in. Available from Science Kit.

Sky Watch

Each day the sun moves through the sky. It rises in the east and sets in the west. In this activity you will do simple investigations to follow the sun's path. All you need is the following:

transparent plastic hemisphere (20 cm diameter)
cardboard base to hold the hemisphere
crayon
protractor

1. Draw a line on the playground or on the sidewalk that goes from north to south. Each hour (for about 5 hours) plot the position of the sun by making a mark on the transparent plastic hemisphere.

2. Using the protractor, determine the number of degrees the sun moves. Draw a line through all the points to describe the path of the sun.

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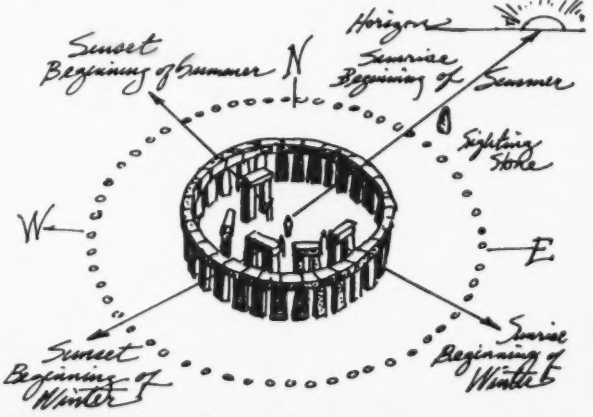
GLOBE KIT

The Globe Kit contains an 8 inch snap-together globe of the Northern and Southern Hemispheres, a base, two transparent hemispheres, a center dish, an external protractor, a 2 inch x 3 inch mirror, an acetate ruler, and two 10 cm rods with suction cups. It costs $6.10 and is available from Science Kit.

FOLLOW THE SUN

Of all the objects in the sky, the sun affects human beings far more than anything else does. The sun has been worshipped, feared, and observed by humans ever since they looked skyward.

One of the earliest observatories used to follow the sun was Stonehenge, which was completed in 1650 B.C. Stonehenge is a prehistoric site consisting of a ring of rocks that scientists believe were used to study the motions of the sun, moon, and planets.



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Building a Simple Sundial

A sundial is a simple instrument on which the shadow cast by a stick is used to tell the time of day. Here is a very simple one that you might like to make. You need only the lid from a "coffee to go" container, a swab stick, and clay.

The easiest way to "set" your sundial is on a globe that you have already oriented.

1. Put the sundial on the globe with clay. (You can put it at your own home spot or anyplace else on the globe, wherever you would like to find the time.)

2. Align the stick with any longitude line on the globe.

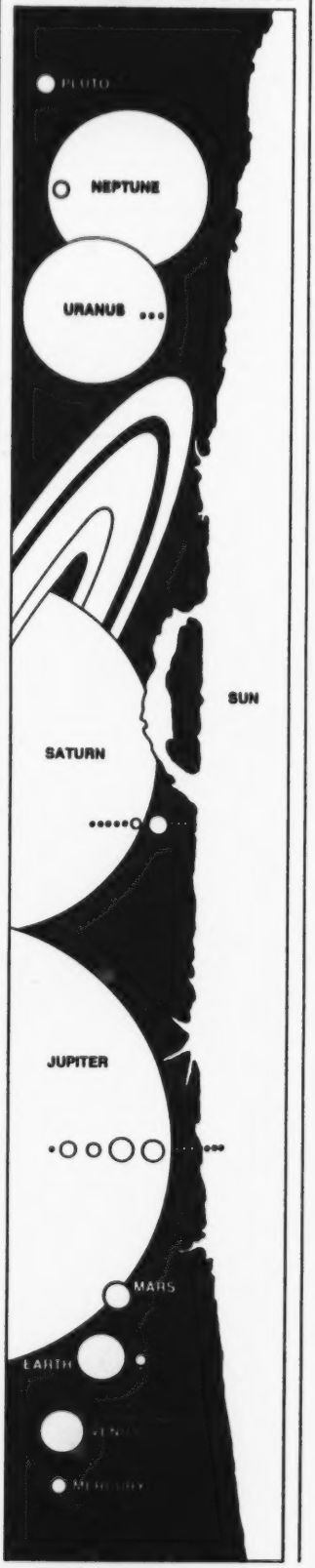
3. Align the dial with any latitude line on the globe. Sight down the lid to see if it is lined up with the equator or any other of the latitude lines. (All latitude lines are parallel to the equator.)

4. Set the dial once by clock time.

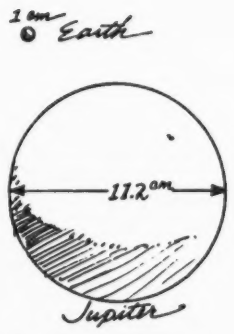
5. Read the time from the spot where the shadow of the stick touches the dial. If your globe is large enough, you can put several sundials on the globe at once to tell time at different locations.

Modified from *Daytime Astronomy*, Elementary Science Study, Webster Division, McGraw-Hill Book Company, copyright© 1971 by Education Development Center, Inc. Used with permission. No endorsement given.

THE SOLAR SYSTEM



PROJECT SOLAR SYSTEM



How far away are the planets from each other? How big are the planets? What do the planets look like? What are the chances of there being life on other planets? These questions are what this project is all about and will involve both art and science. You'll need:

4m of adding machine tape (or string)
plasticine (about 2 pounds)
toothpicks
astronomy reference books

Because the distances between the planets are so large, astronomers have found it easier to think of distances between the sun and the planets in terms of the astronomical unit (AU). This is the distance between the sun and the earth, or 93 million miles.

make scale models of each planet and the sun. The chart below shows the relative sizes of the sun's planets based on the size of Earth.

Object	Scale Diameter (Earth = 1)
Sun	110.0
Mercury	0.4
Venus	1.0
Earth	1.0
Mars	0.5
Jupiter	11.2
Saturn	9.5
Uranus	3.7
Neptune	3.5
Pluto	1.07

For each planet, make plasticine spheres with the diameters shown in this chart. The sun presents a problem. It will be a sphere 110 cm in diameter, or several times as wide as one of the pages in this book. You might want to make the sun out of papier-mâché.

Object	Actual Distance from Sun (miles)	Scale Distance from Sun (Astronomical Units)
Sun	—	0.0
Mercury	36,000,000	0.4
Venus	67,000,000	0.7
Earth	93,000,000	1.0
Mars	142,000,000	1.5
Jupiter	483,000,000	5.2
Saturn	886,000,000	9.5
Uranus	1,787,000,000	19.2
Neptune	2,790,000,000	30.1
Pluto	3,675,000,000	39.5

Using the adding machine tape and the distances given in the chart, make a model of the solar system. Lay the tape out and mark the position of the sun on one end and, measuring 10 cm for each AU, locate the position of each planet in relation to the sun. Now look at the model of the solar system. Two distinct groups of planets should be evident based on their distances from the sun: the inner and the outer ones.

Now turn your attention to the sizes of the sun and the planets. For this part of the project you are going to

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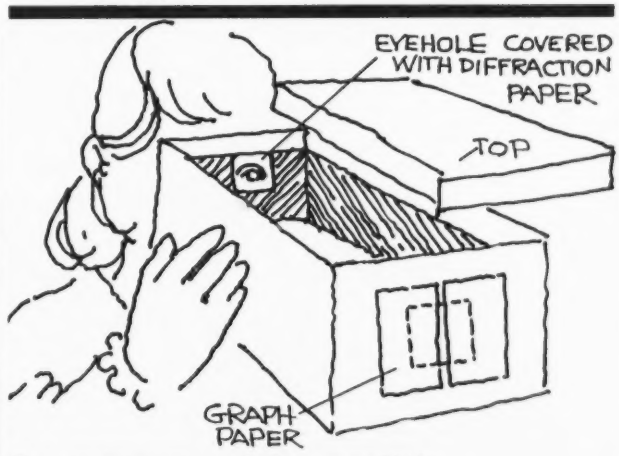
Constructing a Spectroscope



One instrument used by astronomers to study the sun and other stars is the *spectroscope*. This instrument is used to break light up into various parts called a *spectrum*. To build a spectroscope you will need:

shoe box
3 cm x 3 cm piece of diffraction paper (available from Science Kit)
razor blade
piece of graph paper
masking tape

1. Cut a 2 cm square opening at both ends of the shoe box.

2. Cover one end with two pieces of graph paper so that there is a 1 mm slit.

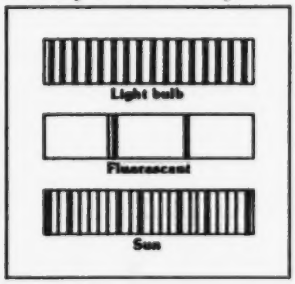
3. Cover the other end with the diffraction paper.

Caution: *Never* look directly at the sun under any conditions.

Using a Spectroscope

Hold the spectroscope with the diffraction paper close to your eye and the other end toward light sources. Look at a variety of light sources, **except the sun. To study the spectrum of the sun, point your spectroscope at the wall of a building or at the sky away from the sun.**

Compare the spectra from different light sources and make diagrams of each, using a variety of colored crayons.



You can also buy an inexpensive tube spectroscope.

DIFFRACTION GRATING SPECTROSCOPE
64799-06 $2.50
These inexpensive diffraction grating spectroscopes illustrate that light can be broken into various colors. The spectrum is viewed on the inside of the plastic tube. The spectroscopes are available in sets of six from Science Kit.

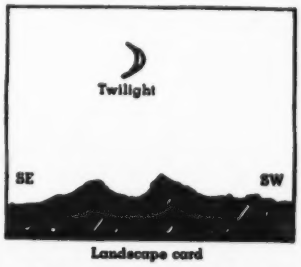
DIFFRACTION PAPER
65681Q $5.75
Excellent for demonstrating the spectrum from various light sources. The paper is mounted in 2 inch x 2 inch slides. Just perfect for the construction of a spectroscope. Package of 25 available from Science Kit.

MOON STUDIES

Observing the moon on a clear night can be a wonderful experience. Several types of studies are suggested, including locating the moon each hour and making a calendar based on the moon.

STUDY 1

Make a drawing on an index card of the landscape around your home. Draw it from the southeast to the southwest.

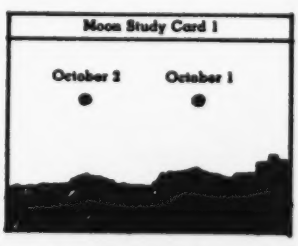


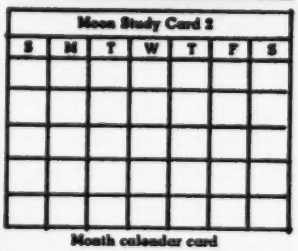
Landscape card

At twilight go out and find the location of the moon. Draw it on your card. Go out every hour for at least two more hours and do the same thing. In what direction is the moon moving? Did it change shape? Compare your cards to those of other people who do this activity.

STUDY 2

This activity will take you about a month. You will need to prepare two things for this study. The first is a landscape card, but this time prepare it on an 8½ x 11 sheet. On a separate sheet prepare a one-month calendar.





Month calendar card

For a month, go outside each night at the same time and do two things:

1. Plot the location of the moon on the landscape card and note the date.
2. Draw the shape of the moon on your calendar card.

While you are doing this study, here are some questions to consider:

1. Does the moon appear in the same place above your landscape each night?
2. What shapes of the moon do you observe?
3. What causes the moon to change phases?
4. How long does it take the moon to go from one full moon to the next full moon?
5. How long would a month be, based on the moon's motion?

STUDY 3

On a full moon night, make a water-color drawing of the moon. Have a "Moon Drawing Day" at school.

STUDY 4

Do each of the studies described above during the daytime.

STUDY 5

Here is a list of research and study questions that you might be interested in explaining:

1. Why does the moon look bigger when it is near the horizon than when it is directly over your head?

2. What does the word "lunatic" mean? How is it related to the moon?

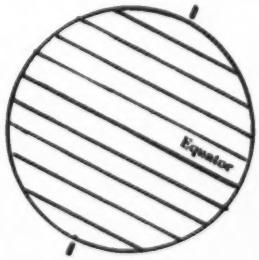
3. Where did the moon come from? Did it fly off from the earth out of the Pacific Ocean? Or was it "captured" by the earth as it passed close to our planet? Or did it form at the same time the earth formed? What do you think?

4. What did we learn about the moon from the Apollo landings?

5. Does the motion of the moon have an effect on biological rhythms of animals and plants?

FINDING YOUR LATITUDE

For people living in the Northern Hemisphere, the North Star is a convenient sky mark indicating latitude.



Latitude lines on a globe

If you were at the equator, your latitude would be 0°, and if you were at the North Pole, your latitude would be 90°.

To find your latitude you need to do two things:

1. Build an instrument to measure the angle of the North Star above the horizon. This angle is equal to your latitude.

2. Locate the North Star.

Building an Astrolabe

The astrolabe was invented by the Greeks, but its use was spread by Islam. "The astrolabe was the pocket watch and the slide rule of the world. When the poet Geoffrey Chaucer in 1381 wrote a primer to teach his son how to use the astrolabe, he copied it from an Arab astronomer of the eighth century."*

To build your own, you'll need:

30 cm ruler or wood rod or stick
protractor
10 cm string
weight (nut)
thumbtacks or tape

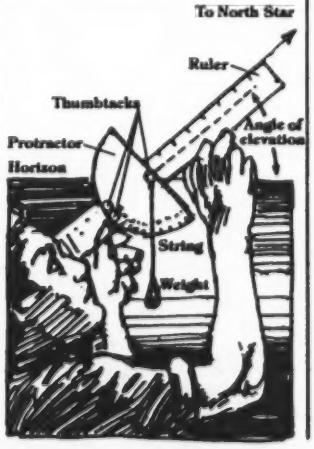
1. Attach the protractor to the ruler with three thumbtacks. Tie the string to the center tack so that it hangs down.

2. Attach a weight to the string.

3. Sight along the top of the ruler to distant objects that are above the horizon. As shown here, the object is about 55° above the horizon as indicated by the string.

4. Practice sighting objects indoors before measuring the stars!

*From J. Bronowski, The Ascent of Man, Little, Brown, and Company, Boston, page 166. Copyright © 1973 by J. Bronowski.



If you do not want to build an astrolabe, you can buy an inexpensive one from Science Kit.

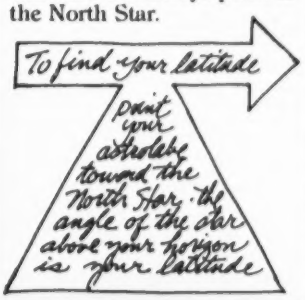
ASTROLABE KIT

The ancient astronomers used an astrolabe to determine the movements of stars and planets. Here is an astrolabe you may be interested in. It costs $2.95 and is available from Science Kit.

Finding the North Star

Go outside on a clear night,

face north (bring a compass!), and try to locate the Big Dipper. When you find the Big Dipper, draw an imaginary line through two of the stars, as shown here. This line will always point to the North Star.


To find your latitude
point your astrolabe toward the North Star. the angle of the star above your horizon is your latitude

GALAXY CARDS

The galaxies shown in the pictures on page 119 in the "Games and Other Nifties" chapter represent the common types of star systems that astronomers see through their telescopes.

Cut out the pictures and paste them on separate pieces of cardboard. There are several activities that you can perform with the cards.

1. Classification. One thing scientists do is to develop systems of classification based on observable characteristics. Organize the galaxies into at least two groups. Describe the basis of your classification to someone else. Do they agree with your system? In which group would you place the Milky Way galaxy?

2. Sequence. Scientists think that galaxies, like stars, evolve. Arrange the galaxy cards in order from the youngest to the oldest.

SOME FAR OUT BOOKS

The Asteroids by Alan E. Nourse. New York: Franklin Watts, 1975, $3.90.
Challenge of the Stars by Patrick Moore. Chicago: Rand McNally, 1972, $6.95.
Comets and Meteors by Isaac Asimov. Chicago: Follett, 1972, $1.68.
Eclipse — Darkness in Daytime by Franklyn M. Branley. New York: Crowell, 1973, $3.75.
The First Book of Mars by David C. Knight. New York: Franklin Watts, 1973, $3.95.
How Did We Find Out the Earth Is Round? by Isaac Asimov. New York: Walker, 1972, $4.50.
How To Read the Night Sky by W. S. Kals. Garden City, N.Y.: Doubleday, 1974, $4.95.
Jupiter — The Largest Planet by Isaac Asimov. New York: Lothrop, Lee, & Shepard, 1973, $5.95.
Now About the World by Edward Holmes. New York: Western Publishing, 1972, $3.95.
Seeing Stars by Patrick Moore. Chicago: Rand McNally, 1971, $3.95.
The Sun by Isaac Asimov. Chicago: Follett, $1.68.
The Tiny Planets: Asteroids of Our Solar System by David Knight. New York: Morrow Junior Books, 1973, $3.95.
Let's Find Out About the Moon by Martha Shapp and Charles Shapp. New York: Franklin Watts, 1975, $4.90.
Pieces of Another World: The Story of Moon Rocks by Franklyn Branley. New York: Crowell Collier, 1971, $4.50.

CHAPTER 14

WOULD YOU BELIEVE

You may wonder why a section on ideas and things that are so far out that they are often not even considered scientific is included in the *Whole Cosmos Catalog of Science Activities*. There are many parts of our world that cannot be explained yet, but they are important to think about. They help us think in some *creative* and imaginative ways. Someday the activities in this section may not seem as far away from real science as they are today. In the meantime, would you believe . . .

A SCIENCE FICTION STORY

Science fiction (SF) is a world for dreamers and for people with beautiful imaginations. You know . . . someone like you! You've probably watched science fiction TV shows or movies or read a science fiction story. Here we are presenting a science fiction story, but it's a little different from those you've probably read. You must supply the ending for this one. The author decided not to give us his ending. So read the story and dream up your own ending the way you want it to be. Do your own dreaming and illustrating. Create new characters, add new lines — anything that you wish.

THE WORLD ENDS IN 12 HOURS

BY PETE SHEPHERD

Twelve light years from here, on a planet called Olympus, live a people, human in appearance, but with a difference: an extra organ, called a *deum*, which is located in the chest cavity, that gives powers we would consider incredible. The capabilities of the deum are determined by heredity. Somehow, when they were first developing, they adopted differing specialties, and now those specialties are passed on from generation to generation.

The Olympians have been subject to countless revolutions, and when they were reduced in number to thirteen, they visited Earth. In a relatively short time they had reproduced to thirty-nine, total. Then there was another revolution. In this revolution, however, ten died. The twenty-nine victors, who have taken the name Patronians (from the Latin *Patros*, or *Patronus* — the former master of a freed slave), have exiled themselves from all intelligent life in an attempt to prevent further corruption and have accepted the responsibility of helping along other intelligent life forms who are less advanced.

"The World Ends in 12 Hours" copyright © 1976 by Pete Shepherd. Used with permission.

There are innumerable planets they have helped, and even more stories of their adventures. Perhaps the most important one is the story of how Alexander, God of War, visited Earth in the late 1950s and had a son by a human woman, but we cannot recount that story here. However, it is a fact that the son, Pete Shep, inherited the deum from Alexander and has made a name for himself, both in the minds and hearts of the humans and of the Patronians.

Travis (messenger of the Gods) teleported down beside Alex, facing Pete.

Pete: *Hi Travis. What's happening?*

Travis: *We need help again. Earth seems to stay in danger constantly.*

Pete: *But fortunately, the Patronians can usually handle the problem without the humans even finding out.*

Alex: *Don't mind him, Travis. What's the problem?*

Travis laid out a scroll (Patronians prefer scrolls because they have no pages to turn) of the solar system with a dotted arrow pointing to it.

Travis: *Here is a familiar sight, the solar system. The arrow shows a meteor storm's path as computed by the Earth Monitor. It would have passed through harmlessly, except for two things: it was attracted by the sun's gravity, and the meteors are metallic in composition and have been magnetized somewhere in deep space so that now they are being attracted by Earth's magnetic field. Due to extenuating circumstances, they were not brought to our attention until too late for Celest to be able to affect them. Austin is willing to help, but he doesn't know what he should do.*

Pete: *Yeah, Austin is plenty strong, but even he can't stop an entire swarm of meteors. Five or six, maybe, but not a whole swarm.*

The adrenalin was beginning to flow in Pete's veins (both Alex and Pete are powerless within 95 million miles of Earth, but Pete's deum can be jolted into activity by adrenalin).

Pete: *Tell Austin to pick out the biggest meteors and start knocking them on courses perpendicular to the path of the swarm. There's a possibility we can nullify Earth's magnetic field long enough for the swarm to pass us by. Alex, go upstairs and work on the angle. I've got a plan of my own to try.*

Alex: *Boy, for a little guy, you sure give a lot of orders.*

Pete: *I try. War Car!*

Metallic Voice: *War Car here.*

Pete gave his location and instructions for rendezvous. Within seconds, War Car arrived.

War Car, to all appearances,

was a slow, lumbering truck. In actuality, all of the storage space was taken up by a combination computer and engine. Neither of the two land vehicles with similar engines (The Spirit of America, owned by Craig Breedlove, and The Courage of Australia, owned by Gary Gabelich) had been driven other than on the Bonneville salt flats. Pete did 85 to the airport, then ordered War Car to meet him in Washington (and God help the poor parking lot attendant who tried to collect from the driverless truck).

At the airport, he boarded Eagle, his private jet, a modified F-111. An expert pilot, he soon had Eagle winging its way toward Washington, D.C.

Within 15 minutes, Pete was in Washington. Those 15 minutes were enough to arrange a meeting with the President, the chiefs of staff, and the top generals at the Pentagon.

Pete: *Gentlemen, we have trouble. You can see the meteor swarm entering our solar system.*

General: *I see it, but I don't see how it substantiates a Priority 1 call.*

Pete: *That's the trouble with you Warmongers. You can't recognize a potential danger when you see it. That meteor swarm is going to pass directly through Earth if we don't stop it.*

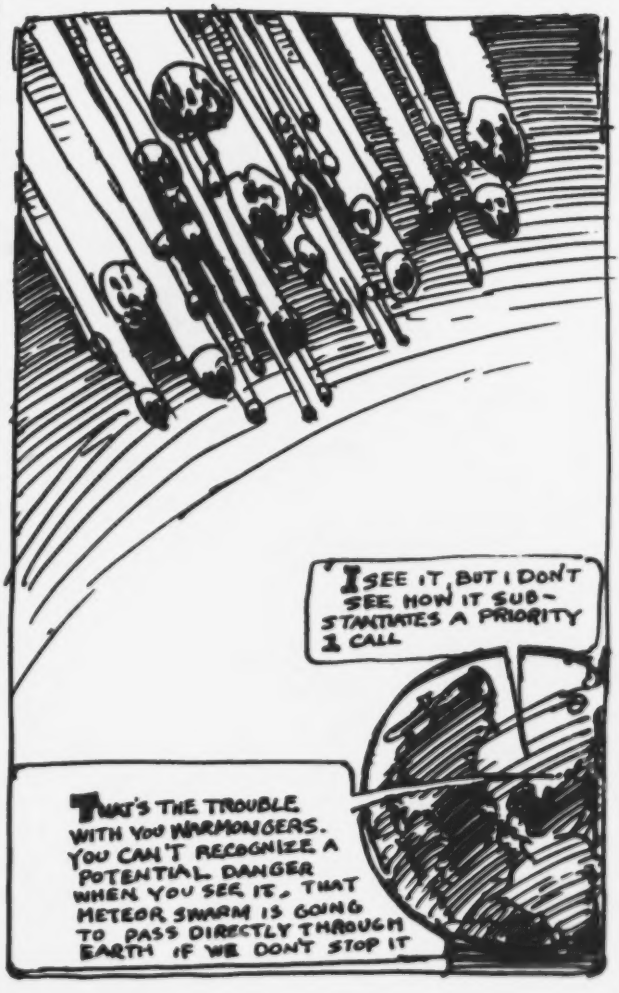
President: *Through Earth, Pete? Isn't Earth substantial enough to stop it?*

Pete: *No, sir, it isn't. That's a big swarm, and it won't leave enough of Earth to hold it.*

President: *What do you propose to do about it?*

Pete: *I've computed the course of the meteor swarm. It's headed for the North magnetic pole, which is in Canada. If our best missiles, short of nuclear weaponry, were fired tomorrow at 0300 hours from the magnetic pole into the swarm, that should deflect the major portion of the swarm away from Earth. If anything goes wrong, the world ends in 12 hours.*

. . . Meantime, Austin knocked meteor number 5


I SEE IT, BUT I DON'T SEE HOW IT SUBSTANTIATES A PRIORITY 1 CALL
THAT'S THE TROUBLE WITH YOU WARMONGERS. YOU CAN'T RECOGNIZE A POTENTIAL DANGER WHEN YOU SEE IT. THAT METEOR SWARM IS GOING TO PASS DIRECTLY THROUGH EARTH IF WE DON'T STOP IT

away from the swarm and a smaller meteor swerved into orbit around it. "Two points for our side," he thought grimly.

. . . And on New Olympus, Alex had determined that to shut off Earth's magnetic field, he'd have to rid Earth of the source of its magnetism, the central core, which is simply a huge dynamo that converts its motion into magnetic energy. He found that he could move the core, intact, through a hyperspace tube, but that left him with three problems: (1) If he didn't plug up the resulting hole, Earth would collapse. (2) How could he plug it fast enough? (3) Where would he find a discarded sphere 4,400 miles in diameter?

. . . Pete was supervising the transport of the missiles into Canada. Despite the usual unbearable slowness of the government at times, this once it was moving at an almost reckless pace. The convoy had no military guard, except for Pete, who, some generals claimed, was undoubtedly wrong about the whole thing.

The U.S. government had just finished retelling the tale to the Canadian government in time for the call to Customs clearing the military vehicles through. The Customs official stood with his hands on his hips, looking very unhappy about the whole thing. Apparently, he didn't have the clearance to find out that the world was about to end.

. . . Austin hit number 8 into the sun. Then he kicked number 9 after it. Number 9 attracted two orbital meteors.

. . . Alex was busily checking the sizes of spheres. Mars was about the right size, but not dense enough. With only two hours left, he continued his searching.

Pete watched Queen Maud Gulf come into view.

Alex found a sphere the right size, but too far from Earth. He had already checked all spheres closer, so he climbed into his Space Armor and went to help Pete.

Austin pounded meteor number 14.

Pete and company arrived at the shore of Queen Maud Gulf just as the aircraft carrier from Thule did. The convoy boarded. The carrier sank noticeably.

Pete asked the captain what an aircraft carrier was doing at an airbase.

Captain: *We weren't actually at airbase Thule, sir, we were a little way out from it, and they were flying planes out to us. They're below decks now, sir. Now, what island was it you said you wanted, sir?*

Pete: *In between Melville Island and Devon Island are two small islands. I want the one closest to Melville.*

Captain: *It will take us about three-quarters of an hour to get there.*

Pete: *That's about an hour too long for me.*

Captain: *We've set these up so that we can leave you with two technicians. As soon as you give the order to fire, they will fire the first missile, which will trigger the others. But, remember, if the first one misses, the others aren't enough. Good luck.*

Pete: *Thanks.*

. . . Austin moved away from the swarm so as to not affect the missiles.

. . . One very small meteor was well ahead of its fellows, and, as luck would have it, slammed into the launcher of the first missile, totally destroying the launcher.

. . . What do you imagine is the fate of Earth? Use your imagination to complete this science fiction story. You can end it any way you wish.

CREATING YOUR OWN SCIENCE FICTION

Inventing ideas for science fiction stories depends upon your imagination. Ideas do not fall out of thin air. In fact, they usually are the result of combining other ideas in new ways. Experiencing the process of invention will help you write science fiction stories.

The Invention Process

1. Find two ideas that don't seem to go together. Combine them to make a third new idea.

2. Have someone give you an object. Invent a substitute for it and then both of you evaluate the invention.

3. Find a way to do some of the following, and figure out what happens:

break a glass with water
sink a piece of wood
bend a rock
stop a light ray

4. Go outside and find something. Find its opposite. Find a way to put these two things together in a way that makes sense. Take this third thing—your product—and find its opposite. Now put these two things together in a way that makes sense. Would you believe that you can continue this process?

If you did a couple of these, then you should now be a little more familiar with inventing and creating new ideas. You should have noticed that many of your good ideas came when you became less serious and started playing around with ideas.

Some of the material in The Invention Process is from ESSENCE II, Addison-Wesley Publishing Co., Menlo Park, California.© 1975 by the American Geological Institute. Used with permission.

Inventing a Story

To help you write a science fiction story, here are some pictures of characters. You can use one or more to invent a story that you create. Your creation can be a play, novel, poem, comic strip, or anything else you wish to develop. Use these drawings not only to help you create your ideas but to illustrate your story.

BOOKS TO S T R E T C H YOUR IMAGINATION

Between Planets *by Robert A. Heinlein. New York: Ace, 1951.* How does it feel to be living far in the future — to be a citizen of an Interplanetary Federation? Robert Heinlein shows us, and he depicts what might happen under such an organization if it were to disregard the rights of the individual. In Heinlein's novel, it is Venus that rebels and starts a revolution.

The Cosmic Connection *by Carl Sagan. New York: Dell, 1975.* Astronomer Sagan writes about such amazing things as: preparing the way for contact with intelligent beings on planets of other stars; space vehicle exploration of the solar system; the search for life on Mars; duplicating the steps that led to the origin of life on Earth, 4 billion years ago.

Fantastic Voyage *by Isaac Asimov. New York: Bantam, 1966.* A James Bond type story about a medical team that travels in a miniaturized spaceship through the bloodstream of a famous scientist in order to dissolve a blood clot threatening the scientist's life.

I, Robot *by Isaac Asimov. New York: Signet, 1950.* A collection of short stories about robots. Asimov invented the "Three Laws of Robotics" and used them in these stories.

The Martian Chronicles *by Ray Bradbury. New York: Bantam, 1958.* This book is a diary account linking several short stories about Earth's attempts to land rockets on Mars.

Other Worlds *by Carl Sagan. New York: Bantam, 1975.* Is there life out there? Our first steps into space have already shown us other worlds stranger than anything in science fiction. This book presents some of Sagan's ideas on: the galactic telephone and the cosmic clock; whether there are big beasts on Mars; the speed of light as a barrier to space travel; and fringe science such as UFOs, astrology, and "chariots of the gods."

Rocket Ship Galileo *by Robert A. Heinlein. New York: Ace, 1947.* A thrilling story of three boys who accompany a scientist on the first piloted rocketship flight to the moon. The time is several years from now. The action is based on scientific fact, and much of it may come true before long. The illustrations have been carefully worked out under Heinlein's supervision, and they are as accurate as it is possible for "projected" illustrations to be.

Heinlein is in the top rank of science fiction writers, and his unusual stories for adults have attracted much attention. This, one of his many books for children, is even more fascinating than the stories of Jules Verne.

Space Cadet *by Robert A. Heinlein. New York: Ace, 1948.* The year is 2075. New cadets are being sworn in at the rocketship training school at Terra Base, Colorado.

The commandant raises his hand: "Repeat after me: Of my own free will without reservation . . ."

"Of my own free will without reservation . . ."

"I swear to uphold the peace of the Solar System . . . To defend the constitution of the Solar Federation."

So Matt and Tex from Terra, Oscar from Venus, Pierre from one of Jupiter's moons, and others put on their uniforms and start their training and their strange adventures in the Solar Patrol.

Exciting, strange, weird, yet realistic and as scientific as a story projected into the future can be, this gives us some idea of what interplanetary communication may mean.

Stranger In a Strange Land *by Robert A. Heinlein. New York: Berkley, 1961.* This is the story of Valentine Michael Smith, born and educated on Mars, who arrives on our planet as a superhuman. He shocks the morals of Western culture by attempting to set up a strange and fascinating discipline on Earth; the first step is learning to Grok.

The White Mountain *by John Christopher. New York: Macmillan, 1969.* In the distant future, Earthmen are ruled by an alien race that controls people's minds through skull caps implanted at the age of fourteen. Three boys escape before they are capped and make a perilous journey to the White Mountains, where there is a band of free men fighting the aliens.

ESP

Do you believe that some people have extrasensory perception (ESP)? Here are several experiments in parapsychology (the study of ESP) that you can use to test the ESP of you and your friends. You will need to cut out the deck of twenty-five ESP cards in the "Games and Other Nifties" section.

Clairvoyance

One type of ESP is *clairvoyance*, or the power to "see" objects or events without using your eyes (or any of your regular sense organs). This experiment will test whether or not you are clairvoyant.

Shuffle the ESP cards well and place them face down on the table. Write down, from one to twenty-five, the order in which you think the cards lie, from top to bottom. Check the cards, keeping a count of your correct answers. Repeat this process three more times. The laws of chance say you should get 20 correct in four runs. Check your results.

Correct Answers	Interpretation
20	Chance
28	Fair success
32	Excellent — high clairvoyance

Telepathy

This experiment will test your *telepathy*, or your ability to "read" another person's mind.

Use the same deck of cards, but this time you will need a partner. Sit facing each other at a table. Shuffle the cards and place them face down in front of you. Your partner will need a piece of paper and a pencil. Draw the top card from the deck, look at it (but do not show your partner), and think the picture to your partner. Just concentrate on the picture and try to send the message to your partner. Your partner should concentrate on your thoughts and then write down which picture he thinks is on the card you are holding. Repeat the process for each card. Then check for the number correct. Repeat the process three more times. Again, by chance your partner should be correct 20 times. Check your results below.

Correct	Interpretation
20	Chance
28	Fair telepathy
32	High telepathy

Thoughts as Objects

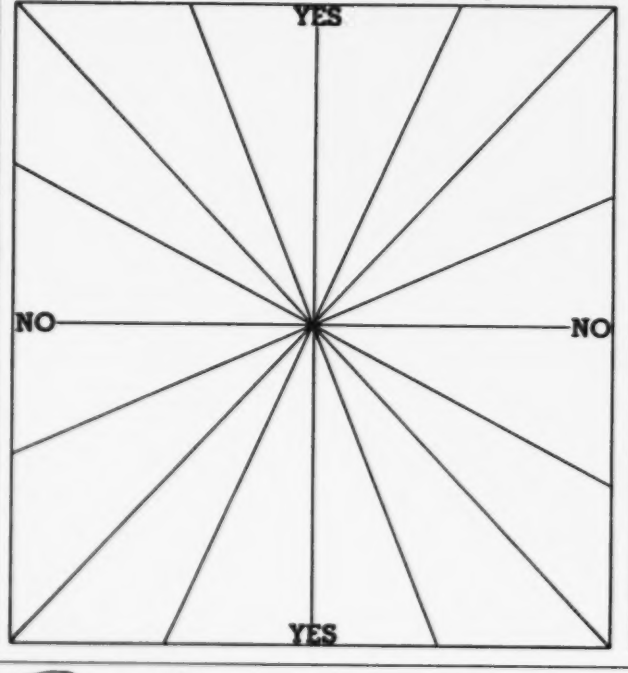
This is a psychic activity that you can experiment with when you are part of a group. Have one member of the group leave something with you that belongs to him or her, such as a ring or picture. Send this person out of the room. Place the object in a visible but not obvious place. Call the person back in.

The person must try to find the object. But there is a twist . . . everyone in the group should think together and send thoughts to the person trying to find the object. No talking or signaling is permitted.

Something like this might happen. The person returns to the room and the object is to her left . . . everyone in the room thinks "turn to your left," then the group might think "walk ahead a few feet," then they might think "look up," and so forth.

Try it. It's a good way to get a group to work together.

This idea was suggested to us by Lawrence Bergman.



The Psychic Ring Pendulum

Do you have questions that you need answered? For years, some people have used a device called the Ouija Board to try to answer their questions. Here is a similar psychic device that you can use by yourself. Tie about 1 meter of string to one of your rings. Hold the string in your hand and dangle the ring over the center point of this page. Ask yourself a question. Concentrate on the question. Your ring should move to give you the answer.

Can you invent a science experiment to find out if the pendulum really works by ESP?

The Beautiful World of Fantasy Trips

Within our minds is a world of fantasy, imagination, and creativity. But how do we make use of our mind to dream up and imagine things? One way to put your imagination to work is to have someone guide you in a fantasy. A few years ago a professional baseball team used a guided fantasy to improve the team's play when they were on the field. That's right! Baseball players were lying on their backs as someone took them on a fantasy trip in which they imagined themselves standing at home plate concentrating on the ball. The players tried to slow down the image of the ball in their minds.

Albert Einstein said that his gift of fantasy meant more to him than his talent for absorbing knowledge.

Many of the images we have of the world (the nature of light, what the inside of atoms and stars look like, our model of genes) are simply fantasy images based on our experiences. We can learn a great deal about the world and how we relate to it by experiencing fantasy.

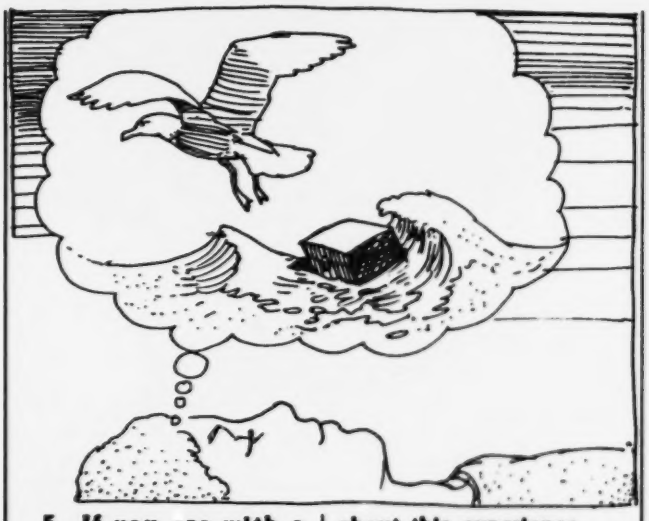
Here are some tips on taking and using the collection of trips that we have provided:

1. It's best to have someone read aloud, pausing for 10 to 20 seconds at the dots.

2. Get yourself into the mood. Keep your eyes closed, lie on the floor, and be in a quiet place.

3. If you don't have a partner, tape-record the trips you want or read slowly, pausing where called for.

4. Go slowly. Do not read through the fantasy trips rapidly. Use a soft, soothing voice.



5. If you are with a group, provide a time for discussion of the fantasy trips. Don't spend time explaining the fantasy. Instead, just try to become more aware of what happened to you.

Body Awareness

Close your eyes and relax . . . let the tension drain from you . . . become aware of how you feel right now . . . just think about it . . . now focus attention on your feet . . . visualize what they look like . . . now move to your legs . . . let them settle to the floor . . . now move your attention to your thighs . . . your hips . . . your buttocks . . . now shift your attention to your stomach . . . let it relax . . . remove all the tightness . . . now become aware of your chest and your breathing . . . now become aware of your hands and your arms . . . let them settle quietly to your side . . . concentrate on your right thumb and fingers . . . now move your attention to your shoulders . . . be aware of your neck . . . your chin . . . your mouth . . . your eyes . . . your forehead . . . quietly think about this experience . . . become aware of the people around you . . . open your eyes and share your experience if you wish.

On the Beach

Close your eyes and make yourself comfortable . . . imagine you are lying on a beach . . . become aware of how the sand feels as you pick up a handful . . . listen to the sound of the surf as it breaks off the shore . . . as you look toward the beach, you see a gull soaring about, sometimes touching down . . . watch what the gull does for a few moments . . . now look out to sea . . . notice the box being lifted and dropped by the waves . . . go out into the surf and bring the box to the shore . . . examine the outside of the box carefully . . . where do you think it came from? . . . now open the box and look inside . . . look at the object inside the box . . . what is it like? . . . examine the object carefully . . . how do you feel about finding this object? . . . now become the object . . . how does it feel to be this object? . . . now become yourself again . . . what do you know about the object now? . . . take the object back to the beach where you were lying . . . what are you going to do with the object? . . . slowly come back to your existence in this room . . . open your eyes and share your experience if you wish.

The Rock

Lie on the floor, close your eyes, and relax . . . imagine that you are walking along a path in a beautiful meadow . . . become aware of the air, its sweetness, and the odors of the flowers . . . listen to the wind . . . do you hear the crickets? . . . as you walk along, you stumble over a rock . . . instead of just moving on, you stop and pick it up . . . notice how the top of the rock feels warm from the sun . . . feel the bottom of the rock . . . look carefully at the rock . . . become acquainted with the rock . . . what colors does it have? . . . do you see any crystals in it? . . . notice its shape . . . notice how it feels in your hand . . . now imagine that you become very small and the rock becomes big, so that you can walk about on it . . . how does the rock look now? . . . now become your normal size and let the rock become its original size . . . now become aware of how it feels to become the rock . . . how did you get to this meadow? . . . where did you come from? . . . how do you feel being where you are now? . . . now become yourself again . . . take another look at the rock . . . now place the rock back where you found it . . . continue on your way . . . slowly come back to your existence in this room . . . open your eyes and share your experience.

I AM A CHILD OF THE UNIVERSE

A One-Act Play

You can enjoy this one-act play by simply reading it. However, we believe you might enjoy acting it out, but with a slightly different casting approach. Instead of building props, such as illustrations of stars and gases, let each of the cast be a person. Of course, Kim, Skip, and Tammy are people, but we're suggesting that people play the part of Stardust, Moriah (a star), Big Bang, the Solar System, and so on. What is it like to be Stardust, or the Solar System? How would you act them out as part of the play? You'll have to get a dozen or so people interested to do it this way. Don't forget to hire a director . . . and a producer . . . and a stage crew . . . and publicity people . . . and ticket salespeople!

The cast (in order of appearance):

Kim	**Hydrogen**
Stardust	**Gravity**
Skip	**Solar System**
Tammy	**Matter**
Moriah (a star)	**Energy**
Big Bang	**Supernova**

Special note for the director:

You should be aware when selecting your cast that only three of the cast members have speaking parts (Kim, Skip, and Tammy), while the remainder of the cast members have parts in which they must be something, such as Moriah (a star), gravity, or hydrogen (an atom). Being these parts could require special props as well as reflection about what it is like to be a star, or an atom, or a force (like gravity) that always pulls things toward it. Here is some information about each that may help you direct your cast members.

Stardust: *Little bits of star! What else?*

Moriah (a star): *Stars are large, give off their own light. They appear to twinkle as we look at them.*

Big Bang: *This is an idea. That's right. The Big Bang is the super-duper explosion that might have happened 13 billion years ago in which all the matter in the universe was blown apart.*

Hydrogen: *This is the simplest atom in the universe. It is composed of one proton (positive charge) and one electron (negative charge).*

Solar System: *This is our system of (nine) planets whirling around the sun.*

Matter: *These are the solids, liquids, and gases that exist in the universe. When acting this out perhaps thinking of something with substance (or stuff) will help.*

Gravity: *This is a force. It causes things to change direction or velocity. Gravity attracts things.*

Energy: *There are many forms, such as light, heat, sound, magnetic, electrical. Energy does its "thing" best when it interacts with matter.*

Supernova: *This is an exploding star.*

Kim: Golly, isn't life exciting! Just think, I'm made out of stardust.

Skip: You're what? Tammy, she's flipped again.

Tammy: Honestly, Kim, how could a star's dust get here? The closest star is 4 light years away.

Skip: Yeah, Kim. That is equal to trillions of miles.

Kim: All right, you two — it is a long story, but it is true. Why, a piece of the star Moriah might be in you, Skip . . . and maybe a piece of Vela X in you, Tam. How about hearing me out?

Skip: [*whispering to*

This play was written by students in Pat Sommerkamp's science class at the Tichenor Middle School, Erlanger, Kentucky. Used with permission.

Tammy] We've got her now, Tam. Bet she can't pull this tale off.

Tammy: Okay, Kim—take off.

Kim: Well, over 13 billion years ago, there was an explosion. They call it the Big Bang. Pure hydrogen gas was then thrown out to all parts of the universe. Today this hydrogen is still moving. About a billion years later, the universe cooled, allowing some of the giant gas clouds to begin to contract . . . and to gradually form the first galaxies.

Tammy: Why didn't the hydrogen gas contract sooner? A billion years is a long, long time.

Kim: The force of *gravity*, which pulls matter together, wasn't strong enough to overcome the outward force caused by the explosion . . . but a billion years later this outward force had lost enough of its power, so that gravity could begin to pull the matter together.

Skip: Are galaxies still forming today, Kim?

Kim: Yes, Skip. The farthest and brightest things astronomers see with their best telescopes are believed to be galaxies being born. They call them *quasars*.

Tammy: Was our Milky Way galaxy the first one?

Kim: No, it came much later.

Skip: Then our solar system had to come later, too?

Kim: Yes, Skip. Our solar system is believed to be no older than 4.6 billion years. A lot of other galaxies with millions of stars have come and gone before ours. But their deaths gave our contracting cloud many elements besides just hydrogen.

Tammy: How can a dying star give another gas cloud anything?

Kim: When large stars die (and they do when they run out of hydrogen), they explode and spread their matter out into space.

Skip: Why does a star die when it runs out of hydrogen? In fact, how does it get born?

Tammy: Kim, I'm confused, too.

Kim: Stars are born when gravity pulls the hydrogen gas atoms close enough together that they can slide over each other, like a stack of coins. At this point, the atoms become welded together forming new elements like helium, carbon, and oxygen. In this process some of the original matter in each hydrogen atom gets turned into pure energy.

Tammy: That can't be right, Kim. Matter can't be destroyed.

Skip: But matter can be changed into energy. Remember that fuzzy-haired Einstein and his famous formula, E equals

Tammy: . . . mc squared?

Kim: That's right. Matter can be turned into energy. Even the smallest, teeniest bit of matter turned into energy is equal to tons of TNT.

Tammy: And that energy is what makes the stars shine so brightly?

Skip: And when the star runs out of hydrogen, she dies?

Kim: Yes, Tam; yes, Skip. The larger stars die violently — exploding when they come to their end. This explosion spreads their newly made elements out into space, where they are attracted by other gas clouds beginning to pull together into stars.

Skip: What will happen to the smaller stars when they die?

Kim: They grow fat and red . . . then they gradually turn into cold, white dwarfs. Astronomers call this a peaceful death.

Tammy: What will our star, the sun, do?

Kim: She is an average-sized star in the middle age of her life. She will, in about 5 or more billion years, turn into a puffy red giant star . . . then she will gradually turn into a cold, white dwarf.

Skip: Wow, Tam! Pick our fate: fry or freeze.

Tammy: You're not funny, Skip. That is terrible — it scares me.

Kim: Tammy, it won't happen for at least 5 billion years.

Skip: Man's gonna choke in his own waste way before that, Tam.

Tammy: You sure are a pessimist . . . a doom-and-gloom man. Kim, what determines whether a star will die peacefully or violently?

Kim: The original size of the gas cloud that gave birth to it.

Skip: Bet the big, thick clouds make the biggest stars and that they explode when they die.

Kim: Right, Skip. But astronomers divide the sizes of the original gas cloud into three groups. Those clouds that are equal in size or smaller than the cloud that gave birth to our sun will die and become white dwarfs.

Those clouds up to three times larger than our sun's was will explode and leave behind a dense, dark core that spins wildly on its axis, sending x-rays and radio waves out into space. These are called *pulsars*, or neutron stars.

Those clouds that are four or more times larger will explode and leave behind an even denser, dark core. These dense bodies draw all nearby matter into themselves. They give off no light, no x-rays or radio waves. They can only be observed when matter near them is being dragged.

Tammy: Do they call these *black holes?*

Kim: Yes, these are the mysterious, super-powerful magnets of dark space.

Skip: What's a *supernova*, Kim?

Kim: Just the name astronomers give a star when it is exploding.

Tammy: Then what is a *nova?*

Kim: The name for the smaller stars turning into white dwarfs — they kinda sparkle in brighter, uneven bursts before they quiet down.

Skip: Are any new stars being born right now?

Kim: Yes, Skip. These star nurseries are in the Great Nebula in Orion, in the Trifid Nebula, in the Pleiades star cluster, in the Horsehead Nebula, and in many other places.

Tammy: Can we see any supernovas now?

Kim: We can't see the star exploding that the Chinese saw in 1040, but its gaseous and dusty remnants can still be seen. Astronomers call the remnants of this star the Crab Nebula. Galaxies have one supernova about every 300 or 400 years. The last one in our galaxy was in 1604.

Skip: Neat, this means we are due for another one any time now. And say, Kim, about those black holes . . . any near our star?

Kim: Astronomers believe there is one in the constellation Cygnus, the Swan, also in the center of the galaxy.

Skip: Say, I bet that black hole will swallow up so much matter that he will eventually explode . . . and start that big-bang scene all over again.

Kim: Skip, you *are* intelligent, after all.

Tammy: I'm impressed. In fact, I feel super-important right now. Just think, the stage upon which I was born is the huge universe of billions of stars. And even though neither I, nor any person, will probably ever be able to visit near them, I still feel close — connected to them. For their life and death made my life possible. I'm truly a child, not of Earth, but of the whole universe!

Skip: Yeah, Tam, as the saying goes, "A time for everything . . . a time to be born and a time to die."

Kim: Ain't you glad you listened? Tammy, like you said . . . I, too, feel so important.

Skip: What an opening night!

Tammy: And what kind of a performance we give . . .

Kim: . . . is all up to us!

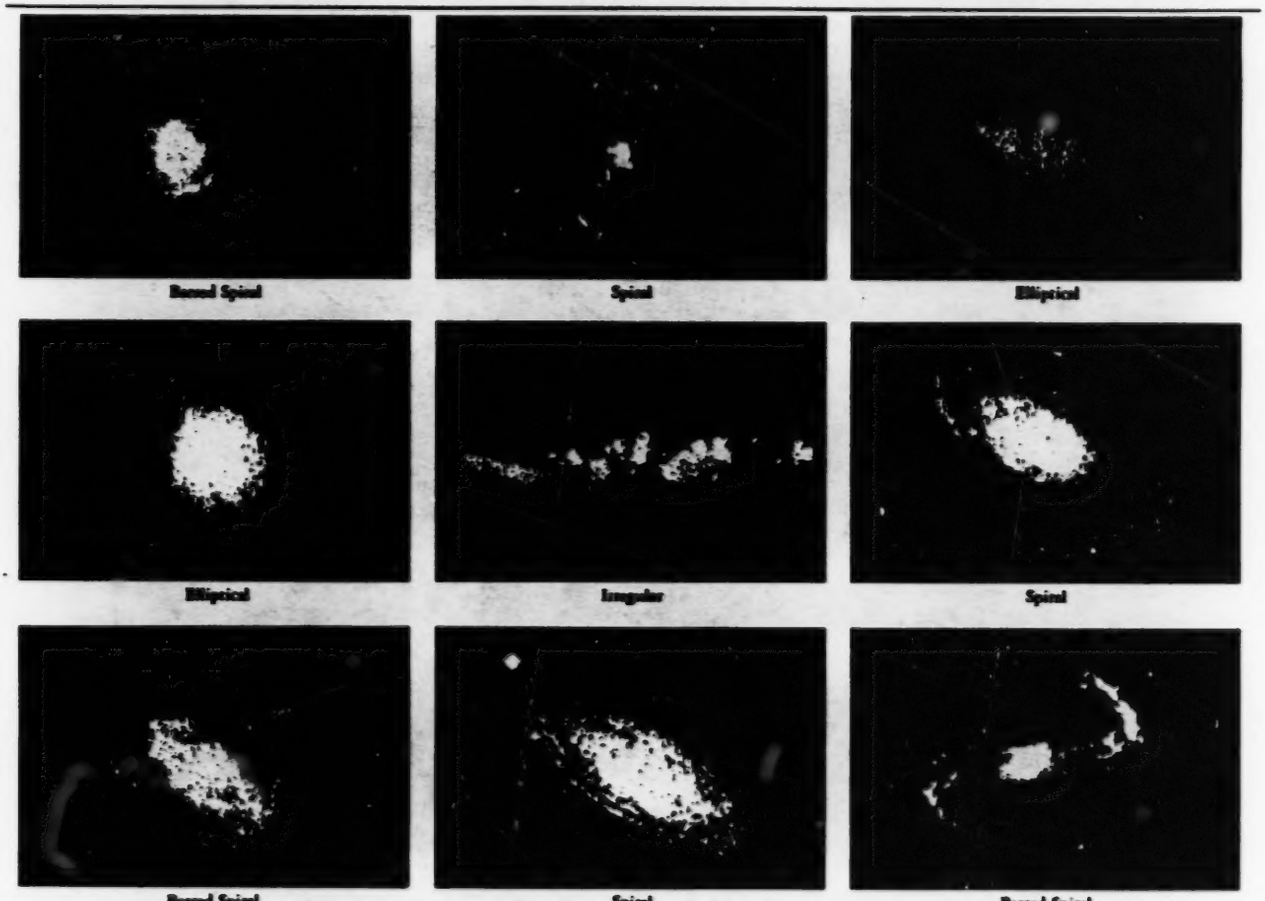
CHAPTER 15

GAMES AND OTHER NIFTIES

Galaxy Cards
Litterburg
The Fat Game
The Living Game
Continents A-Go-Go
The Challenge Game
The Wet and Wild Game
Watch the Birdie
ESP Cards

GALAXY CARDS

A Cut-out Collection of Your Favorite Stars (A Cast of Trillions!)



Barred Spiral | Spiral | Elliptical

Elliptical | Irregular | Spiral

Barred Spiral | Spiral | Barred Spiral

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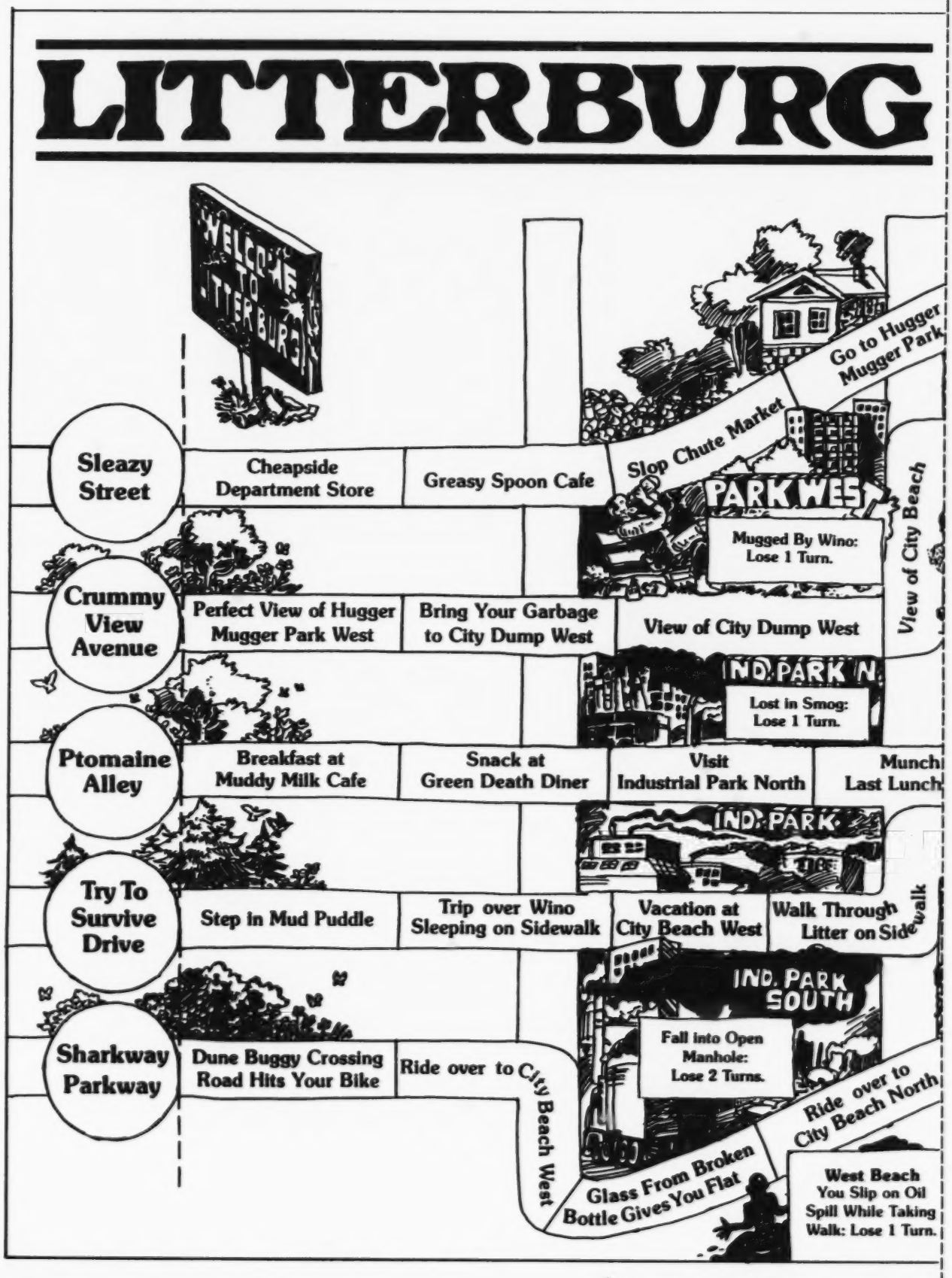
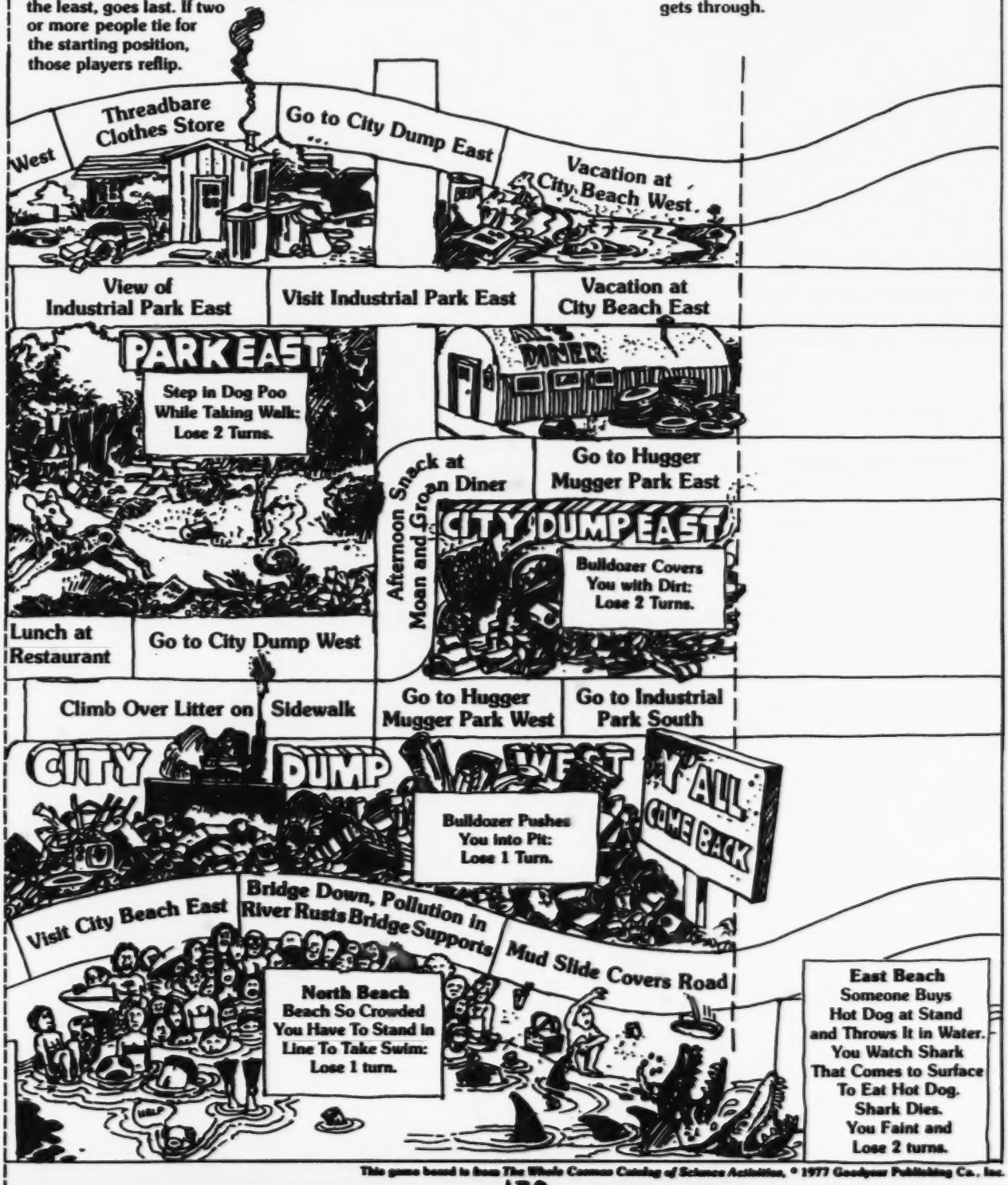

LITTERBURG
WELCOME TO LITTERBURG
Sleazy Street
Cheapside Department Store
Greasy Spoon Cafe
Slop Chute Market
Go to Hugger Mugger Park
PARK WEST
Mugged By Wino: Lose 1 Turn.
View of City Beach
Crummy View Avenue
Perfect View of Hugger Mugger Park West
Bring Your Garbage to City Dump West
View of City Dump West
IND. PARK N.
Lost in Smog: Lose 1 Turn.
Ptomaine Alley
Breakfast at Muddy Milk Cafe
Snack at Green Death Diner
Visit Industrial Park North
Munch Last Lunch
IND. PARK
Try To Survive Drive
Step in Mud Puddle
Trip over Wino Sleeping on Sidewalk
Vacation at City Beach West
Walk Through Litter on Sidewalk
IND. PARK SOUTH
Fall into Open Manhole: Lose 2 Turns.
Sharkway Parkway
Dune Buggy Crossing Road Hits Your Bike
Ride over to City Beach West
Ride over to City Beach North
Glass From Broken Bottle Gives You Flat
West Beach
You Slip on Oil Spill While Taking Walk: Lose 1 Turn.

Getting ready
1. Pick a street.
2. Put a small marker (button, bead) at Start.
3. Starting order: Each player flips a coin five times. The person getting the most "heads" in five flips goes first. The person getting the least, goes last. If two or more people tie for the starting position, those players reflip.

Playing
1. Each player takes a turn flipping a coin. If the coin comes up "heads," the player moves the marker two spaces. If "tails" comes up, the player moves the marker one space.

2. Players sent to Hugger Mugger Park, City Dump, Industrial Park, or City Beach lose the number of turns indicated and return their markers to Start.
3. First player to get through Litterburg wins.
4. Play continues until everyone gets through.


Threadbare Clothes Store
West
Go to City Dump East
Vacation at City Beach West
View of Industrial Park East
Visit Industrial Park East
Vacation at City Beach East
PARK EAST
Step in Dog Poo While Taking Walk: Lose 2 Turns.
DINER
Afternoon Snack at Moan and Groan Diner
Go to Hugger Mugger Park East
CITY DUMP EAST
Bulldozer Covers You with Dirt: Lose 2 Turns.
Lunch at Restaurant
Go to City Dump West
Climb Over Litter on Sidewalk
Go to Hugger Mugger Park West
Go to Industrial Park South
CITY DUMP WEST
Bulldozer Pushes You into Pit: Lose 1 Turn.
Y'ALL COME BACK
Visit City Beach East
Bridge Down, Pollution in River Rusts Bridge Supports
Mud Slide Covers Road
North Beach
Beach So Crowded You Have To Stand in Line To Take Swim: Lose 1 turn.
East Beach
Someone Buys Hot Dog at Stand and Throws It in Water. You Watch Shark That Comes to Surface To Eat Hot Dog. Shark Dies. You Faint and Lose 2 turns.

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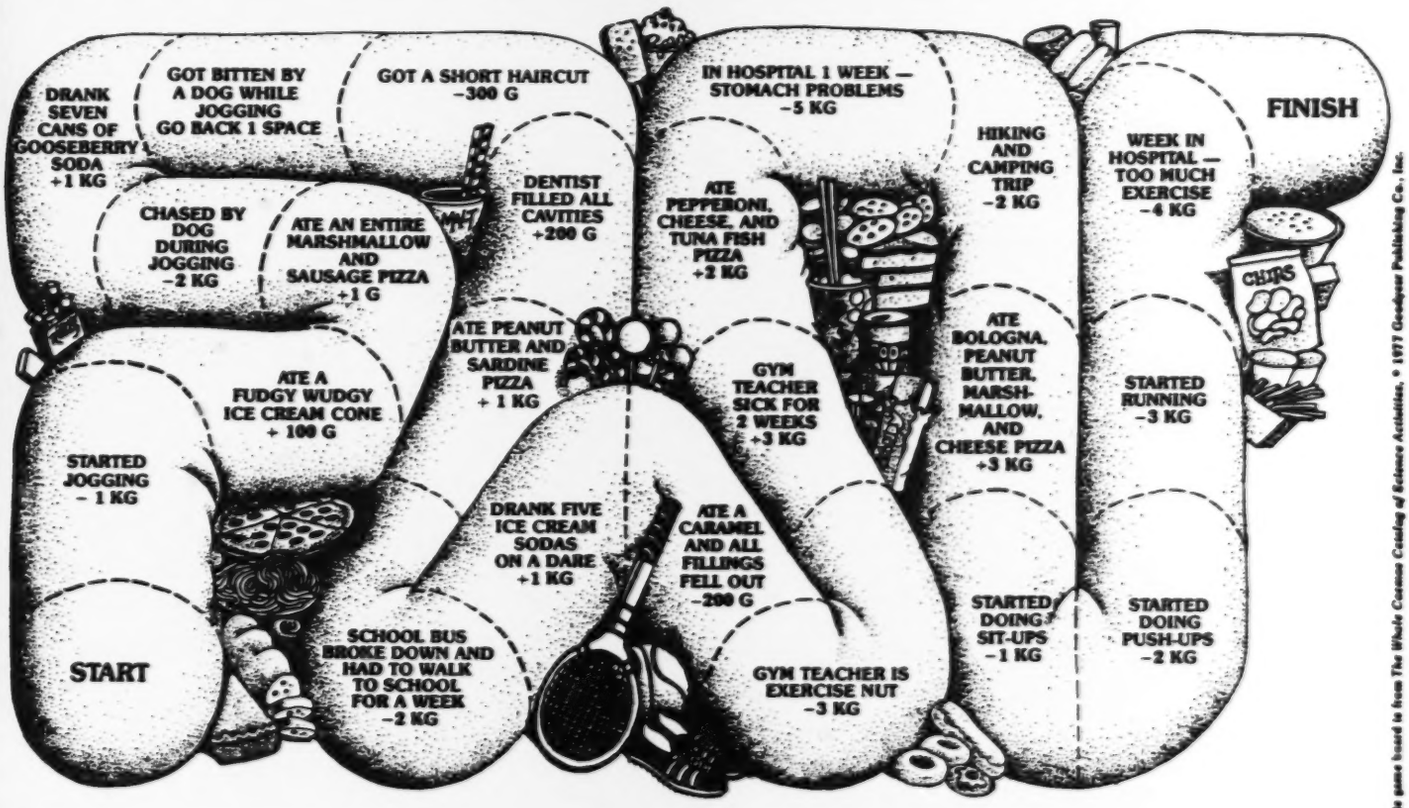
THE FAT GAME

YOU CAN PLAY THIS GAME WITH TWO OR THREE PEOPLE.
MATERIALS: GAME BOARD, PENCIL AND PAPER FOR EACH PLAYER, A FEW PENNIES, AND ONE DIE.
DIRECTIONS:
1. EACH PLAYER FIGURES OUT HIS OR HER MASS IN KILOGRAMS AND WRITES IT DOWN. (TO FIND YOUR MASS, DIVIDE YOUR WEIGHT IN POUNDS BY 2.2. THIS WILL TELL YOU HOW MANY KILOGRAMS YOU WEIGH SINCE 2.2 LBS. = 1 KG.)
2. EACH PLAYER TAKES A TURN AND ROLLS THE DIE. THE PLAYER GETTING THE HIGHEST NUMBER STARTS THE GAME. EACH PLAYER TAKES ONE PENNY TO USE AS A MARKER.
3. THE PLAYER GOING FIRST ROLLS THE DIE AND MOVES HIS OR HER PENNY THE NUMBER OF SPACES SHOWN ON THE DIE.
4. WHEN A PLAYER LANDS ON A SPACE, HE OR SHE ADDS OR SUBTRACTS THE MASS WRITTEN ON THE SPACE FROM HIS OR HER OWN MASS. (NOT ALL OF THE MASSES ARE WRITTEN IN KILOGRAMS SO YOU WILL HAVE A CHANCE TO PRACTICE CHANGING GRAMS TO KILOGRAMS.)
5. SOME OF THE SPACES HAVE SPECIAL DIRECTIONS ON THEM. IF YOU LAND IN SUCH A SPACE, YOU MUST MOVE YOUR PENNY IN THE WAY THAT THE DIRECTIONS TELL YOU TO.
6. THE GAME ENDS WHEN ALL THE PLAYERS HAVE CROSSED THE FINISH LINE.
7. THE WINNER IS THE PERSON WHO LOSES THE MOST MASS. IF NO ONE LOSES MASS, THE PERSON WHO GAINS THE LEAST WINS.


START
STARTED JOGGING −1 KG
DRANK SEVEN CANS OF GOOSEBERRY SODA +1 KG
GOT BITTEN BY A DOG WHILE JOGGING GO BACK 1 SPACE
GOT A SHORT HAIRCUT −300 G
CHASED BY DOG DURING JOGGING −2 KG
ATE AN ENTIRE MARSHMALLOW AND SAUSAGE PIZZA +1 G
DENTIST FILLED ALL CAVITIES +200 G
ATE A FUDGY WUDGY ICE CREAM CONE + 100 G
ATE PEANUT BUTTER AND SARDINE PIZZA + 1 KG
SCHOOL BUS BROKE DOWN AND HAD TO WALK TO SCHOOL FOR A WEEK −2 KG
DRANK FIVE ICE CREAM SODAS ON A DARE +1 KG
ATE A CARAMEL AND ALL FILLINGS FELL OUT −200 G
GYM TEACHER IS EXERCISE NUT −3 KG
GYM TEACHER SICK FOR 2 WEEKS +3 KG
IN HOSPITAL 1 WEEK — STOMACH PROBLEMS −5 KG
ATE PEPPERONI, CHEESE, AND TUNA FISH PIZZA +2 KG
HIKING AND CAMPING TRIP −2 KG
ATE BOLOGNA, PEANUT BUTTER, MARSHMALLOW, AND CHEESE PIZZA +3 KG
STARTED DOING SIT-UPS −1 KG
WEEK IN HOSPITAL — TOO MUCH EXERCISE −4 KG
STARTED RUNNING −3 KG
STARTED DOING PUSH-UPS −2 KG
FINISH
CHIPS

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THE LIVING GAME

These cards can be used to play some games that will help you find out about a variety of organisms.

Game 1 is an acting game, the second game is an identification game, and the last game is one you invent yourself.

Game 1

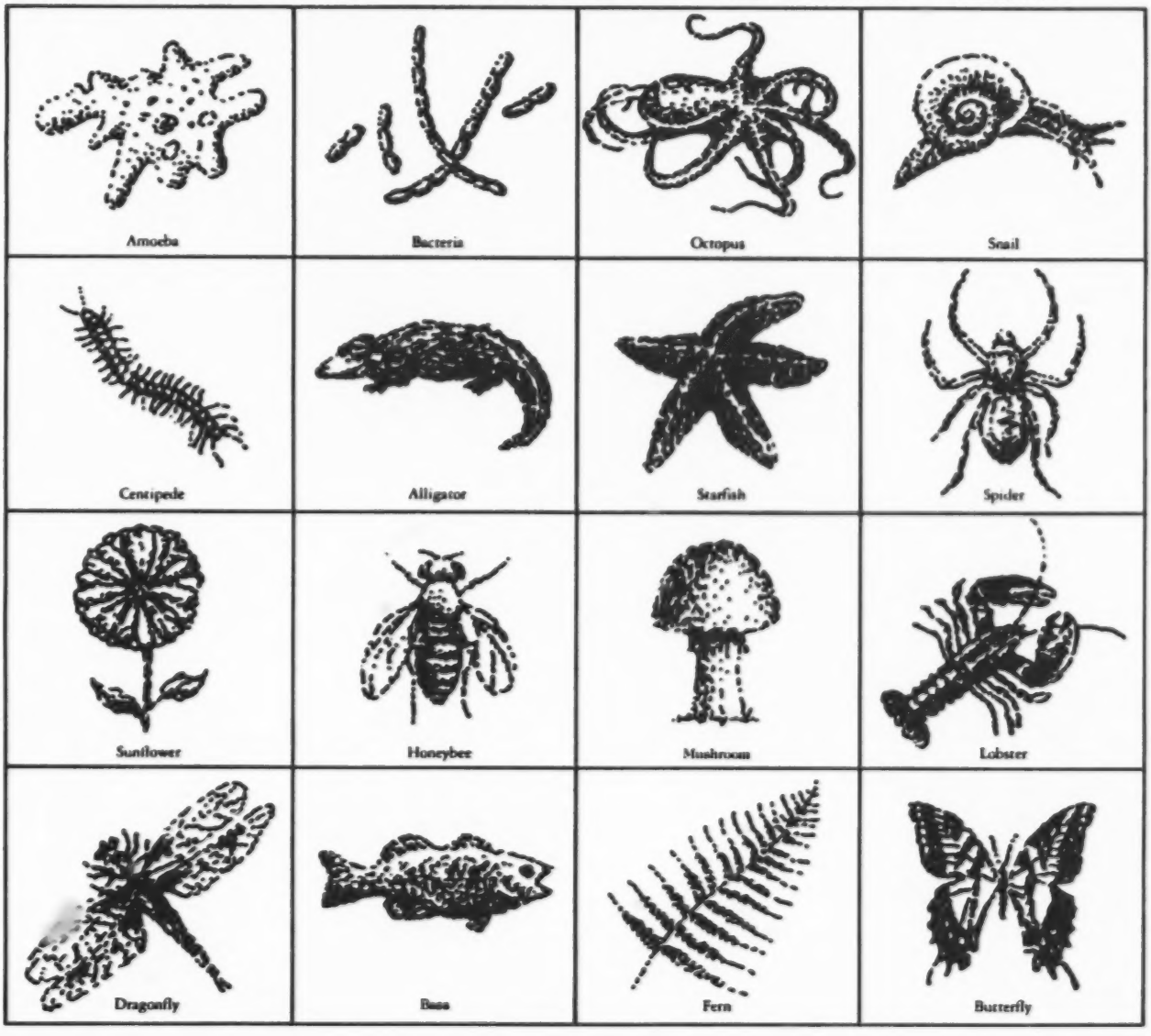
Objective:
To communicate as many organism names as possible by acting out — using gestures and actions only.
Materials:
Complete deck of organism cards.
Players:
Two teams of at least three players each.
Rules:
The teams alternate acting out the names of the organisms. One player from the first team picks a card from the deck. Using only gestures and actions (no words or props), the player acts out the organism. Spelling the name of the organism with the body is not allowed. The player should try to convey behaviors or characteristics of the organism so that members of his or her team can guess the plant or animal. One point is scored for each identification within a time limit of 2 minutes. Teams should agree on the number of points needed to win.

Game 2

Objective:
To identify organisms.
Materials:
Complete deck of organism cards. Collection of organisms, such as plants, ferns, moss, insects, and so on.
Players:
Two to four.
Rules:
Place the organisms between the players. Deal each player five cards. Place the rest face down between the players. The player who starts draws one card from the deck. Using the cards in his or her hand, the player tries to match one or more of the cards to the organisms between the players. If a match is made, the player removes the organism from the pile and places it in front, with the card face up. If an identification is made, the player draws another card. If a player cannot make another match, then he or she discards the card, placing it face up next to the deck. One point is scored for each organism identified. The game ends when all the organisms are identified. The winner is the player with the most points.

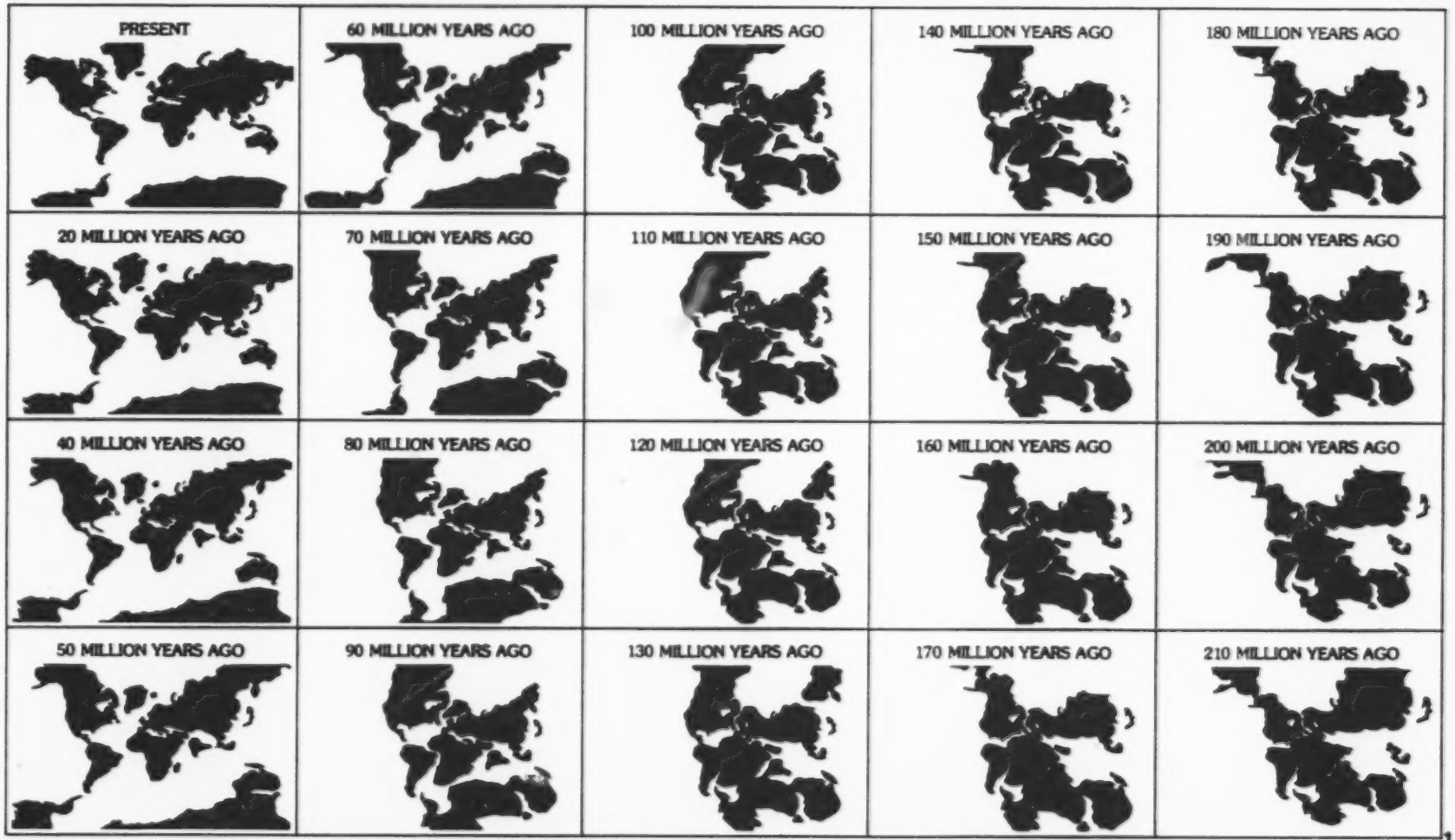
Game 3

Objective:
To create your own game.
Materials:
Organism cards and anything else you need to invent a game.
Players:
Depends upon the game you create.
Rules:
They are up to you.



CONTINENTS A-GO-GO

To play Continents A-Go-Go, you will need to cut these cards out and then staple them together. The age of the earth is printed on each card. Notice that the continents started to split up about 210 million years ago. To see the continents do their dance, flip the deck of cards.



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Maps based on drawings appearing in Scotese and Baker, "Continental Drift," *Journal of Geological Education*, Vol. 23, No. 5, pp. 169–170. © 1975, C. Scotese.

THE CHALLENGE GAME

DIRECTIONS

1. Set these "challenges" up in different places in the room.

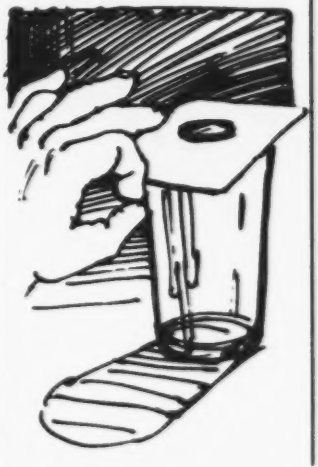
2. Each player tries each "challenge" until he/she gets it.

3. The player doing the "challenge" writes the number of "tries" on the scoreboard.

4. The person getting the *lowest* total score wins.

1 COIN DROP

Put an index card on a glass.
Place a coin in the center of the card.
Can you get the coin to drop into the glass by giving the card a quick flick with your index finger?



2 MARBLE DROP

Put some sand or cotton in the bottom of a glass.
Place an index card on the glass.
Put a marble in the center of the card.
Can you get the marble to drop into the glass by giving the index card a quick flick with your index finger?

3 KARATE CHOP

Place a strip of paper over the lip of a cup.
Put a coin on the paper strip so that it is balanced on the lip.

Hold the end of the paper strip.
Can you give the strip a Karate chop and keep the coin balanced?

4 THE LOOP

Make a loop of heavyweight paper that is at least 3 cm wide and 15 cm in diameter.
Place the loop on a cup and balance a coin on it.
Can you hit the inside of the loop with a pencil so that the coin falls into the cup?

SCOREBOARD

Player	Challenge Number				Total
	1	2	3	4	

THE WET AND WILD GAME

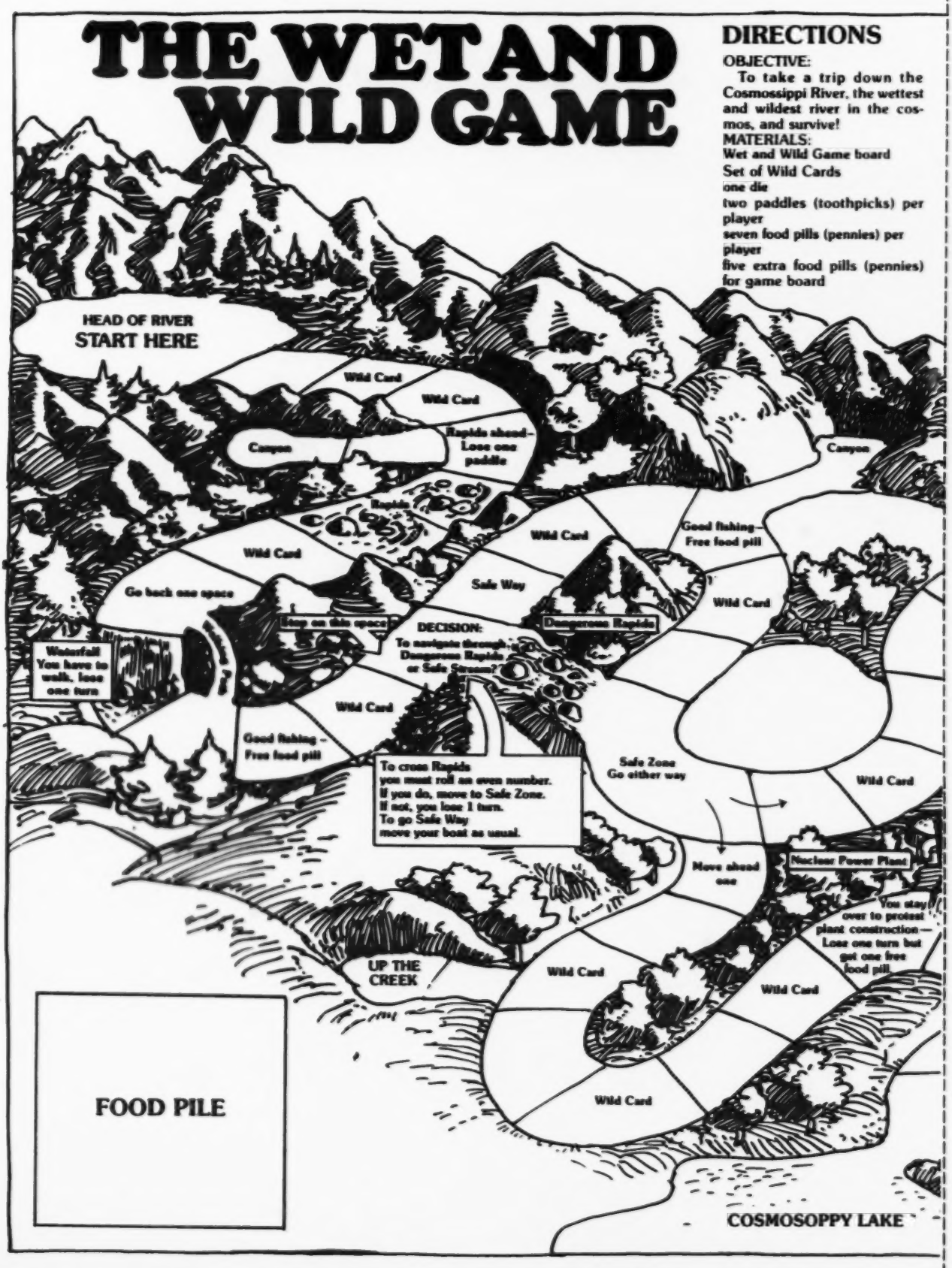
DIRECTIONS

OBJECTIVE:

To take a trip down the Cosmossippi River, the wettest and wildest river in the cosmos, and survive!

MATERIALS:

Wet and Wild Game board
Set of Wild Cards
one die
two paddles (toothpicks) per player
seven food pills (pennies) per player
five extra food pills (pennies) for game board



THE COSMIC DAM PROJECT. The Cosmic Dam is being built. You must carry your boat 2 miles across land to enter water again. Lose one turn or a food pill.

COASTAL EROSION. A severe storm packing high winds and rains and producing huge ocean waves has destroyed the coastal station where you are heading. You boat flips over and you lose one paddle.

SIERRA CLUB OUTING. You meet a group of people on a camping and river trip who belong to a national conservation club. They give you food and wish you well on your journey. Take one food pill from the food pile.

TEMPERATURE POLLUTION. A power plant has pumped hot water into the river, raising the temperature above health levels for plants and animals. There is no source of food for you. Lose one food pill.

ERUPTION. A volcano has erupted. The volcanic lava changes the course of the river. Move back three spaces.

DROUGHT. The area you are in has had no rain for 2 months. The river has dried up in this area. Lose one turn while you wait for rain.

CHEMICAL POLLUTION. A large chemical plant has dumped huge quantities of acid into the river. Your aluminum boat is in danger of being dissolved. Move back to the nearest canyon, where the pH of the water is neutral.

BONUS WILD CARD. You collect one food pill. Enjoy it.

JUST A NORMAL DAY ON THE COSMOSSIPPI RIVER. Wait for your next turn.

AVALANCHE. A huge snowslide hits the river just ahead. Move back to the nearest canyon behind you.

ROCK SLIDE. Severe rock slides occur ahead, temporarily destroying the river channel. Lose one day on journey. You lose one turn and must give up one food pill.

UP THE CREEK. Move your boat to "Up the Creek" and, you guessed it . . . without a paddle. You lose one paddle.

TORNADO. With no warning, you sight a tornado. Move ahead or back to the nearest canyon for safety.

FLOODING. Heavy rains have increased soil erosion in the river. The fish that you hoped to catch have either died or been forced away. You lose one food pill.

GOOD FORTUNE. You meet two young people fishing along the river bank. They give you food. Would you believe — a free fish fry! Take one food pill from the food pile.

SUPER WILD CARD. This card can be used at any time during the game to get you out of any trouble. You can also use it to get one paddle or one food pill back. Keep it until you need it.

GOOD FORTUNE. You pass an old river captain who gives you one food pill. Take one from the food pile.

FLOOD. Heavy rains (and poor land management) cause a flood. During the flood your boat turns over. You lose one paddle.

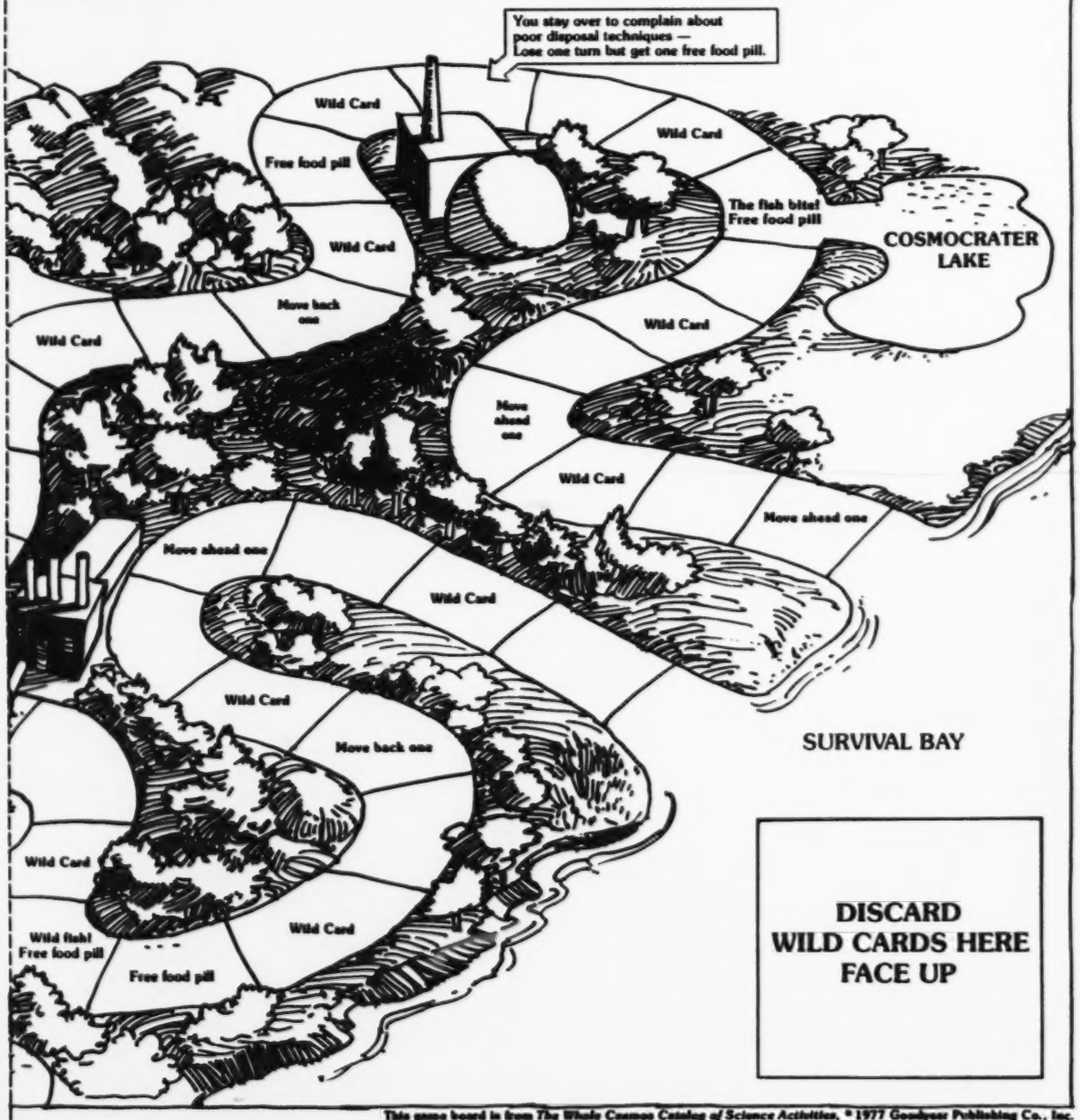
GOOD FORTUNE. You find an extra food pill hidden under a can in your boat from the last trip. Take one food pill from the food pile.

RAPIDS. The next quarter mile is the most dangerous section of the river. While moving swiftly through the rapids your boat is overturned. Guess what! You lose one paddle.

Wild Card	**Wild Card**	**Wild Card**	**Wild Card**
Wild Card	**Wild Card**	**Wild Card**	**Wild Card**
Wild Card	**Wild Card**	**Wild Card**	**Wild Card**
Wild Card	**Wild Card**	**Wild Card**	**Wild Card**
Wild Card	**Wild Card**	**Wild Card**	**Wild Card**

two pieces of aluminum foil 10 cm x 10 cm (fold each to form a small boat, one for each player)
PLAYERS: two
RULES:
1. Each player starts at the head of the river. Place seven food pills and two paddles in each boat. Place the Wild Cards and extra food pills on the game board.
2. The youngest player goes first by rolling the die and moving ahead the number of spaces shown on the die. Players follow instructions on the squares that they land on.
3. On each roll of the die (which represents one day on the Cosmossippi River), the player uses up one food pill, which is placed on the Food Pile on the game board.
4. The first player to lose all food pills and both paddles is out of the game, and the other player is the winner.

PLACE WILD CARDS HERE



DISCARD WILD CARDS HERE FACE UP

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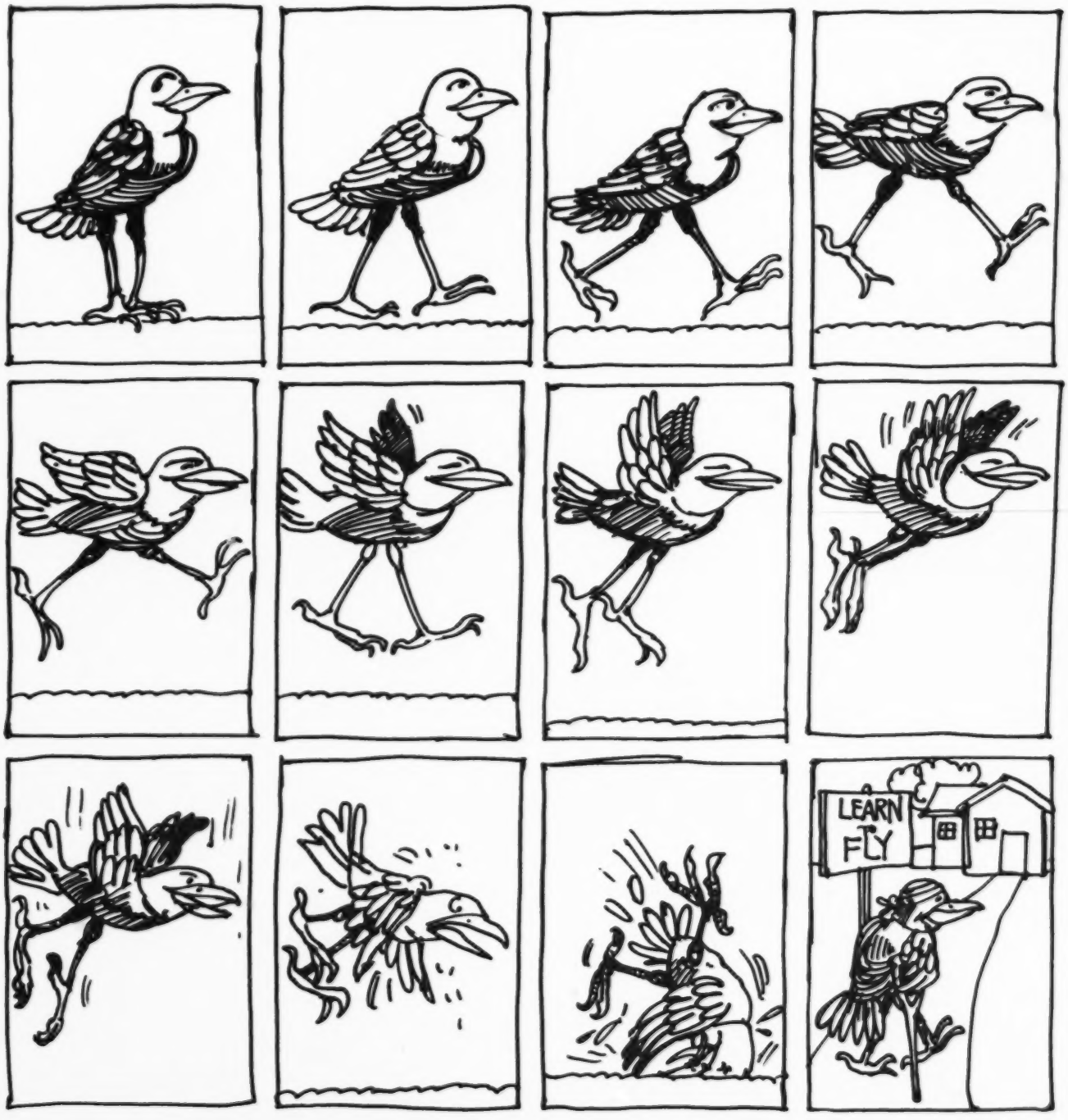
cut out cards and staple together in order to

WATCH THE BIRDIE



ESP CARDS

Cut out and use to test your extrasensory perception.

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ABOUT THE AUTHORS

Joe Abruscato and Jack Hassard are presently involved in the preparation of humanistic science experiences for use by young people and teachers. *The Whole Cosmos Catalog of Science Activities* fulfills their desire to provide within one volume a wide range of activities that foster a healthy, natural curiosity about science.

The authors' previous book, *Loving and Beyond: Science Teaching for the Humanistic Classroom*, also published by Scott, Foresman, is a widely used methods and activities textbook for teachers and curriculum developers. Both authors are actively involved in teaching preservice and inservice courses, developing curriculum materials, and conducting workshops and inservice programs.

Joe Abruscato is presently a faculty member in the College of Education, University of Vermont, Burlington. Jack Hassard is a faculty member in the School of Education, Georgia State University, Atlanta.

SPECIAL CREDITS

We would like to take this opportunity to thank in a general way all those individuals and agencies who have kindly granted us permission to include their materials. Throughout this catalog we have tried to give credit to each identifiable source of ideas.

Some of the material in this book is abstracted or adapted from various curriculum projects, including the Science Curriculum Improvement Study (SCIS), Science A Process Approach (SAPA), Earth Science Curriculum Project (ESCP), Intermediate Science Curriculum Study (ISCS), Essence, and the Elementary Science Study (ESS). We encourage the readers of this catalog to refer to these original sources for additional activities.

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